Trade Liberalisation, Openness and Economic Growth in Less-developed Countries

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To my mother, Martha

with love and admiration

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I take full responsibility for any errors or omissions in this thesis.

Appendices

Tables

CHAPTER 1
Introduction

1.1 Background

A number of studies, including those in the World Bank and the IMF, would suggest that trade liberalisation is an integral part of economic reform in developing countries. Although trade liberalisation is a well researched area, there are still some remaining issues that need to be addressed. Most of the earlier studies focus on establishing a link between trade policies and long-term economic performance, measured in terms of productivity or per capita GDP growth. Although theories promoting inward-oriented policies emerged in the fifties and sixties, the unsustainable and often destructive effects of import-substitution policies have, by and large, been discredited with the realisation that potential benefits of an open trade regime may outweigh its costs. In the early 20th century, openness was not a popular policy while protectionism dominated, and during the fifties a majority of developing countries followed it as a genuine path to industrialisation.

The strategy of import substitution was first introduced by Prebisch (1950) and Singer (1950), and it was based on two fundamental postulates that: (i) the income per capita gap between the rich and poor would be larger if developing countries continue to rely on producing primary goods which is susceptible to price fluctuations and (ii) that the newly developing manufacturing sector in less-developed countries need protection. Throughout the fifties and sixties, this protectionist view was embraced by many economists and international institutions, such as the World Bank and IMF, and a considerable time was devoted to structure the implementation of import-substitution strategies. Nevertheless, the protectionist paradigm was not without serious sceptics who pursued empirical analysis of the alternative trade strategies. Employing a different methodology, ranging from historical to econometric, researchers provided evidence, which indicates that the outward-oriented countries perform better than the inward-oriented countries. In the seventies, the view that openness to trade is a better way for development started gaining some support among economists and policy makers.

The debt crisis of the 1980s played a crucial role in reforming domestic policies in developing countries. The poor performance of the Latin American countries, most of which pursued the strategies of import-substitution revealed a contrast to the success story of the East Asian economies that implemented an outward-oriented policy (see Table 1.1).

Table 1.1

Export and Growth in sub-Saharan Africa, Latin America, and Asia

1970-1999.

	Real GDP		Manufacturing		Exports	
	1970-85	1985-99	1970-85	1985-99	1970-85	1985-99
Sub-Saharan Africa	3.1	-0.5	2.4	-3.5	-2.2	1.6
Latin America	5.8	1.4	6.7	1.3	-1.4	3.9
East Asia	7.4	7.8	11.2	12.8	10.3	10.4

Source: Own calculation based on data obtained from World Bank's World Development Indicators (2000).

In the 1980s researchers and lending institutions began to recommend outward-orientation as a development strategy, which involves a substantial reduction of trade barriers and devaluation of the domestic currency. On the basis of increasing empirical evidence, the World Bank, IMF and other lending institutions changed their views about import-substitution strategy and made outward-oriented trade policy a routine requirement for financial assistance. Despite significant trade reforms in developing countries, there still remain some controversies regarding the role of trade in the success stories of outward-oriented economies. Some economists (such as, Sachs, 1987) argued, for example, that the success of the East Asian economies was to a large extent, due to an active role of government in promoting exports in an environment where imports had not been fully liberalised, and where macroeconomic equilibrium was fostered. Rodrik (1993), a prominent critic of free trade regime, argues that in most empirical studies, the "trade regime indicator used is typically badly measured and often is an endogenous variable itself (p. 17)".

Developed nations account only about 20% of the world's population, however 70% of global production and trade are taking place among these countries. Developing countries, on the other hand, account for about 80% of the world's population but lag far behind the developed nations in terms of global production and trade. The role of trade and trade policy in the process of economic growth has been a long debating issue since the earlier studies by Balassa (1978), Bhagwati (1978) and Krueger (1978) who attempted to find econometric evidence that supports export-led growth. The notion of international trade as an engine of growth is not new, going back at least to Adam Smith's era. Although there are disparities amongst developing countries in terms of economic performance, their backwardness is often supposed to impinge upon sharing a common theme of trade policy. Many of the developing countries structure their trade policy in favour of manufacturing sector at the expense of traditional sectors. Moreover, developing nations attempted to use trade policy as a remedy for narrowing inequalities in the domestic income distribution, and for resolving balance of payment problems.

The development of the theoretical literature on trade and economic growth seems to have gone through two distinct periodical phases. In the 1960s and 1970s many economists explored the neoclassical growth theory in the context of the Heckscher-Ohlin-Samuelson (HOS) trade model. The neoclassical growth theory emphasises that there is a growth effect as a results of trade policy that boosts the return to investment. According to HOS model, global trade liberalisation raises capital's rental rate and the return to investment in countries that export capital-intensive goods.

The past two decades have witnessed (the ebb and flow of) a growing number of studies aimed at exploring the impact of international trade on economic growth (e.g., River-Batiz and Romer, 1991; Grossman and Helpman, 1991; Feenstra, 1999). The emergence of the new growth models pioneered by Lucas (1986, 1988) and Romer (1987) was the main reason for the resurgence of this topic.

Despite the voluminous empirical literature employing comparable analytical models (framework), and important theoretical advances that explains how trade is related to growth, there still remains considerable controversy to be resolved regarding the impact of trade on growth. There are a number of reasons for such conflicting views. One of the main reasons is that the differences in which researchers approach their investigation. Some researchers, for instance, hypothesise the causal relationship between trade and growth, while others study the impact of government policies on trade and economic growth. However, the issue of openness to trade and its impact on growth and whether a country's policy is inward or outward oriented dominate the focus of many of the studies in this area. The definitions of these concepts used by individuals do affect the outcome of the results and hence the conclusions drawn from it. Some define openness by considering trade flows or duties imposed on trade, and in some cases non-tariff trade barriers (e.g., Feder, 1983; Edwards, 1993, 1998). Others consider the foreign exchange rate regime and competition and other regulatory policies (e.g., Krueger, 1978; Dollar, 1992).

The quality and sampling technique used in collecting data is the other source of dissents amongst economists. Studies that deal with the impact of trade on growth of developing countries are hugely affected by the quality of the data and usually they tend to consider time series analysis of individual countries. Although a number of issues could be analysed on the basis of the results of such kind, it is improbable to suggest the applicability of the findings to other countries due to their specificity.

A number of studies have indicated that developing countries, which are technologically backward, are able to exploit a back-log of existing technologies (e.g., Gerschenkron, 1952; Grossman and Helpman, 1991). The assumption behind these studies is that since imitation is relatively less costly than innovation, developing countries can attain high productivity growth than developed countries. Consequently, technologically less advanced countries tend to grow faster than technologically leading countries. Several studies have shown that trade is the main channel through which, technological spillover takes place from the advanced countries to less-developed countries.

Despite enormous efforts to analyse the effect of international trade on economic growth, it seems an important factor has been ignored. It is the capacity of developing countries to adopt new technologies. For developing countries to take advantage of available technology from the advanced countries, it is necessary to attain well-developed absorptive capacity, that is, the technological ability of a country to absorb the new knowledge (knowledge spillovers) made available through free trade. We suggest here that the absorptive capacity is determined by a country's human capital endowment and quality of infrastructure (see Appendix 1 for description on absorptive capacity). Openness can be conducive to growth, if a country is adequately endowed with human capital and high quality of infrastructure.

For any technology adoption to be functional, less developed countries need to have well developed absorptive capacity. This suggest that even if two countries have the same degree of openness, the actual technological catching up is determined by their relative absorptive capacity, which, in turn, depends on their human capital endowment and quality of infrastructure. Policy remedies may be appropriate for one country to rectify some macroeconomic malaise but the same may be improper for another or even to the same country at a different time with different economic conditions. Cross-country empirical findings, however compelling they might look to researchers, may not apply to some individual countries with specific characteristics. Generalised policy prescription arising from a single econometric model could be futile to countries with different economic characteristics.

1.2 Research Objective

The main objective of this thesis is to analyse empirically the role of international trade in the process of economic growth of developing countries. In doing so, we attempt to examine the factors that determine the absorptive capacity of the countries. We aim to investigate what limits developing countries from adopting new ideas. The absorptive capacity here is defined as the ability of the country to adopt and implement new technologies developed in the advanced nations and made available through free trade. We use a wide range of openness measures in the regressions to test the impact of international trade on economic growth. We then proceed to examine if the results for full sample hold for countries with a different level of development. Unlike most earlier cross-country studies we run different regressions for different sample countries that are divided on the basis of their real income per capita. This aims to resolve the highly debated issue concerned with whether openness is beneficial to all countries regardless of their level of development.

The second objective of the thesis is to investigate what determines the absorptive capacity of the country. We examine the direct impact of human capital and infrastructure on economic growth, and their influence in determining the effect of openness. We test the significance of human capital and infrastructure by including them in the regression and also interacting them with openness measures. This attempts to capture whether openness is a sufficient condition for countries to achieve higher rates of growth or whether it depends on the ability of the country to absorb new ideas. For example, the ability of Uganda with a relatively low stock of human capital and poor infrastructure (as compared to Singapore with higher stock of human capital and better infrastructure) to adopt new knowledge will be poor. By examining such data the thesis aims to provide greater insight into the mechanism of technological adoption through trade.

1.3 Structure of the thesis

The thesis is organised as follows: Chapters 2 and 3 present the theoretical and empirical literature review, respectively. These chapters provide extensive summary of the research that are related to international trade and economic growth. Chapter 4 empirically examines the impact of openness on total factor productivity. In this chapter we replicate Edwards' (1998) empirical work and examine if the results hold for all groups of countries with different levels of development. Furthermore, we investigate if the results differ for different time periods.

Chapter 5 presents an extension of Chapter 4 by using panel data set. In this chapter we test various specifications to examine the consistency of the results. In Chapter 6 we present the regression analysis that employs a Feder (1983) type of model, while Chapter 7 presents a multivariate causality test. In the Chapter 8 we attempt to overcome the shortcomings of earlier studies by developing a simultaneous equation model that captures the most important features of the international trade and economic growth nexus. Using a panel data set, we test the simultaneous equation model by employing instrumental variable (3SLS) techniques. Finally, Chapter 9 discusses the main findings of the thesis and draws some conclusions and policy implications by identifying some areas for further research.

CHAPTER 2

Theoretical Literature on Trade and Growth: A Survey

2.1 Introduction

The main purpose of this chapter is to review and analyse critically the literature dealing with the relationship between openness and economic growth. Although a number of studies have explored the potential impact of trade on growth, it is not easy to establish the relationship. Studies on economic growth lead to some problems such as endogeneity of certain variables, while the empirical papers have not been able to provide unambiguous results of the impact of trade on growth (Thirlwall, 1979; McCombie and Thirlwall, 1996; Edwards, 1992, 1998; Grossman and Helpman, 1990, 1991; Rodrik, 1999; Rodriguez and Rodrik, 1999; Sachs and Warner, 1995; Srinivasan and Bhagwati, 1999, among others).

This chapter attempts to address the question surrounding the relationship between international trade and economic growth in theory. The literature on the issue of trade and growth begins from the dynamic extension of the Heckscher-Ohlin model (Hechscher, 1919; Ohlin, 1933). Some models demonstrate how economic growth can affect the pattern of international trade, as for example, Oniki and Uzawa, (1965). The recent models of trade and growth incorporate endogenous product innovation within the framework of integrated world equilibrium. Thus, the development of the theoretical literature on trade and economic growth seems to have gone through two distinct temporal phases. In the 1960s and 1970s many economists explored the neoclassical growth theory in the context of the Heckscher-Ohlin trade model. After the birth of the new growth theory, in the late 1980s, economists used endogenous growth theory to develop trade models with imperfect competition. The new growth theory, that endogenises the technology factor, emphasises that any government policy that causes technological change will have a permanent growth effect. A number of economists have employed the endogeneous growth model to show the impact of trade policy on economic growth.

2.2 Trade and Growth in the Classical Growth Model

Classical theories include the contribution by Smith (1776) who developed the concept of the absolute advantage and that of Ricardo (1817) who developed the concept of comparative advantage. The Ricardian trade model considers two-countries, two commodities and one factor of production (labour). Technology is assumed to be fixed (in terms of units of labour required to produce one unit of goods) in the production process of each commodity. Therefore, relative labour productivity determines the pattern of international trade between the two countries. In the absence of transport costs, trade between the two countries will be determined by the comparative cost of production. If each country specialises in goods in which she has comparative advantage, both countries will achieve welfare gains and the world welfare will also improve. The efficiency gains of international trade in Ricardian model are widely discussed in several international trade text books (see for example, Gandolfo, 1994 and Borkakoti, 1998), and it is not necessary to restate them here.

The Ricardian model explains the welfare gains if a country that specialises in the production of the good in which it has a comparative advantage. According to Ricardo, progressive nations are those with high savings, accumulation of capital, output, productivity and demand for labour forcing the increase in wages and demographic growth. In the Ricardian model productivity of labour is the primary cause of trade between countries. However, labour productivity is determined by other factors, such as technological changes and capital per worker, which can also be considered as the sources of international trade. Although the Ricardian trade model does not deal with the impact of trade on growth, it can be argued here that gains from trade lead to higher income, which increases savings and investment. Thus, in this sense, international trade contributes to economic growth. Using a dynamic Ricardian model, Findlay (1984) shows how trade retards the rate of economic growth. The model shows that international trade leads to a fall in the rate of growth, in comparison with autarky, in a country, which exports primary (agricultural) goods and imports manufacturing goods. This results from the fact that the increase in rents is absorbed by luxury consumption whilst the fall in the rate of profit reduces capital accumulation.

2.3 Trade and Growth in Neoclassical Growth Model

Following the work of Heckscher (1919) and Ohlin (1933), Samuelson (1948 and 1949) developed the neoclassical general equilibrium models to explain how free trade leads countries to specialise in the good(s) relatively intensive in the factor which is relatively more abundant in the country. The Hecksher-Ohlin-Samuelson (HOS) model demonstrates the welfare gains in the two-country, two-factor, two-good model and shows how each country specialises on the basis of their factor endowments. According to the HOS model, international trade leads to a Pareto-efficient equilibrium that yields higher welfare through its effect on the allocation of resources between sectors. Movements in relative prices create intersectoral factor reward differentials that encourage entrepreneurs to move the factors until the differentials in factor rewards are cleared.

Suppose a country is exporting labour-intensive goods and importing capital-intensive goods. Opening up to trade results a fall in the domestic relative prices of importable goods. Consequently, assuming the economy is on the Production Possibility Frontier (PPF), output increases in the export sector while it falls in the import sector. Since exportable goods are labour intensive compared to importable goods, a shift in the composition of output increases the demand for labour and decreases demand for capital. Thus, there will be a new equilibrium at which real wages increase and the capital rental falls, resulting a change in the income distribution. The model favours openness to trade by implying that it is beneficial to both trading parties, and favourable to the entire world. The whole analysis, however, is limited to the extent of static gains of welfare from trade.[1]

The basis of the Ricardian and HOS theories is that international trade is the way to achieve static productivity efficiency and global competitiveness. Although productivity efficiency and international competitiveness is achievable through trade, the two classic theories (Ricardian and HOS) have not shown whether and how free trade affects long-run

[1] We may also have to note here that the empirical studies do not always support the H-O-S argument (see Leontief, 1953).

economic growth (For an extensive explanation of these models, see Gandolfo, 1994; and Borkakoti, 1998).

Using a dynamic model of international trade, Oniki and Uzawa (1965) demonstrate the effect of endogenous capital accumulation on the pattern of trade. The model considers two countries, two goods (consumption and investment) and two factors of production (labour and capital) which are assumed to be fully employed. Trade between the two countries takes place in both consumption and investment goods. Investment goods are accumulated as capital. Labour and capital, once invested, are immobile between the countries. Consumption goods are instantaneously consumed. Allowing labour to grow at a constant rate and assuming that the average propensity to save is identical between the countries (with internationally identical technology), Oniki and Ozawa prove that a globally steady-state exists. Any arbitrary given capital-labour ratios of the two countries converge to the steady-state capital-labour ratios, as they do so the pattern of trade changes, exports, imports and the terms of trade also change over time. The model gives the time path of all these variables.

Another strand of analysis deals with the movement of the terms of trade and economic growth is Bhagwati's (1958) immiserising growth, where growth (either due to technical progress or factor accumulation) leads to a sufficiently acute deterioration in the terms of trade which imposes a loss of real income outweighing the primary gain in real income due to the growth itself. Johnson (1967) has further shown that the phenomenon of immiserizing growth (that reduces social welfare below the initial pre-growth level) can also arise in the case of a small country without any monopoly power in trade if technical progress occurs in a tariff-protected import competing industry, or if the factor in whose use this industry is intensive is augumented. In the Bhagwati's case, the welfare impact of growth in an open economy can be reduced because the primary gain from growth might be offset by the secondary loss from an extended to assert that the secondary loss may even outweigh the primary gain, resulting in immiserizing growth.

Young (1928) is probably the first economist who considered economic growth in his analysis which is concerned with the size of the market that determines the labour employment and hence productivity. Moreover, he examined the relationship between the industries of the country in the process of economic growth, the inception of new industries because of product specialisation as a result of market expansion, the efficiency of specialisation and normalisation in a larger global market and the impact of such a market on technological advancement.

In his consequential classic papers, Schumpeter (1912, 1942 and 1954) recapitulated the earlier arguments regarding the direction of the profit to reach its minimum level and how capital accumulation determines the growth rate of the economy. Furthermore, he discussed the core factor that determines economic growth, by distinguishing between 'invention' (development of a new idea) and 'innovation' (economic activity, exploring the new idea for productivity purpose). He considered innovation as the main factor explaining economic growth and elucidated the main facets for lucrative innovation including openness to international trade.

Economists, who advocated inward-oriented and protectionist policies began to demonstrate the adverse effect of international trade for LDCs [Prebisch, 1949 – who was executive secretary of UNTAD; and Singer, 1950 – who was head of Economic Commission for Latin America (ECLA)]. They suggested that international trade had a negative impact in the long-run growth of LDCs since these countries could only specialise in goods which had low demand income elasticity, low prospects of export growth and constantly declining terms of trade. They also went on describing the economic and social cost of acclimatisation to the cycle of international trade.

The general implication of the models discussed above is that international trade leads to higher potential welfare. Based on these analyses the policy implication to be drawn is that opening up to trade is a better alternative, since trade liberalisation policies tend to improve, at least, welfare in static efficiency model. However, most models make some strong assumptions and these traditional trade models provide weak empirical support (Rodrik, 1999). Some of these limitations are dealt with in the new trade theory. The fundamental difference between the old and new trade theories is that the new trade theory takes in to account the market structure, namely, imperfect competition. One of the main features of the new trade theory, is that it considers economies of scale. Moreover, it explores and also justifies the missing link that comparative advantage and factor endowments do not explain (Helpman and Krugman, 1985; and Krugman, 1990).

In support of the traditional trade theory and criticising the critics of outward-oriented trade policies, Srinivasan and Bhagwati (1999) argue that traditional trade theory still shows the best way to understand trade and growth. They suggest openness to trade, capital and technology flows contribute to the sources of growth. According to Srinivasan and Bhagwati it is a mistake to criticise the impact of trade on growth in the traditional trade model on the ground that openness to trade allows countries to exploit their comparative advantage, knowledge and innovation.

2.4 Trade Policy in Developing Countries

Trade policy in developing countries is usually characterised by a preference for the manufacturing sector at the expense of other sectors, such as agriculture and mining. Developed countries mainly export manufacturing products while poor nations export mainly primary goods, and this trend would suggest the extent to which that manufacturing sector is taken to be the core of development. The economic structure of developed nations (where a large proportion of total GDP is dominated by manufacturing output) provided the most influential theoretical underpinning in favour of manufacturing sector over the primary good (agricultural) sector.

The infant industry argument emphasises that developing countries' governments should protect the growing manufacturing sector until they are able to compete in the world market with the well-established industries from the developed countries. According to the infant industry argument developing countries need to use temporary protection measures to induce industrialisation. The entrepreneurs in developing countries need time to be efficient in mastering how to use the imported capital goods (equipment). Unless they acquire the necessary experience, they will not be able to produce profitably at the world price. The most prominent examples of industrial countries (USA, Germany and Japan) used high protection measures (high tariff rates) at the early stages of their industrialisation process, and the achievements of these countries provided persuasive complement to the infant industry argument.

2.4.1 Import substitution and the infant industry argument

The past few decades (between 1960 and 1980) have witnessed a dismal economic growth, with the exception of a few (the Asian tigers, India and China), in all developing countries, and it remains gloomy for a majority of Asian, Latin American and African countries. The concept of import substitution industrialisation (ISI) was first introduced by Prebisch (1950) and Singer (1950) with two basic objectives: first, the reduction of the increasing gap in per capita income between developed and developing countries requires developing countries to expand their industrial sector instead of their price-susceptible primary goods sector; second, domestic infant industries need protection from well established foreign industries.

In the 1950s and 60s import substitution was the popular trade policy in developing countries, and the strategy of ISI was to identify the type of imported good which has high demand in the domestic market and impose certain protective measures after ensuring that domestic producers have the technological know-how to produce locally. Although larger economies pursuing the ISI strategy were successful in reducing their imports, increasing technological sophistication - particularly in the manufacturing sector, such as computer and machine equipment - has made ISI strategy limited in its application to developing countries. Developing countries were forced to carry on importing capital goods and newly developed equipment.

In the sixties a number of economists (including those in the IMF and the World Bank) supported the idea of protectionism and the majority of developing countries pursued an import substitution strategy to improve their economic performance. The policy of import substitution envisages that developing countries would get the opportunity to complete the learning process while the domestic entrepreneurs are protected from the foreign competitors. These countries then are able to design their own path to industrialisation. The basic idea is that import substitution provides an opportunity to domestic agents to learn, master the new knowledge and create an economy which is capable of resisting foreign competition. According to import substitution theory, developing countries need protection to achieve the stage where they will be able to have sustained growth in the economy.

There are two fundamental phases in the successful process of import substitution strategy: phase I is characterised by a transition from dismal economic growth to a sustained economic growth, where the economic welfare of the society improves continually (a constant growth of welfare of the society). Phase II is characterised by gradual dismantling of trade barriers when these countries become active in the world market competition.

It has been argued that the success of some of the newly industrialised economies (e.g. Korea and Taiwan) is a result of appropriate implementation of import substitution strategy; whereas the failure of India to achieve the level of success of these countries is caused by inappropriate method of implementation, although the failure has nothing to do with the strategy itself (Bruton, 1989). Developing countries need protection to acquire a strong economy that can utilise its resources at an optimum level and create its own way of preserving a sustained economic growth. The theory of protection emphasises that developing countries need protection to acquire new knowledge. In the context of continuous change, in terms of technology and both social and political activities, learning is at the core of the strategy for economic development of a country under protection (Bruton, 1989). Protection is argued to generate an incentive for the economic agents to actively participate in the learning activities.

Although ISI was embraced by many developing countries in the 1950s and 1960s, there has been a serious doubt considering ISI as a policy that generates economic growth, particularly, in the 1970s ISI was under serious scrutiny in various studies (e.g., Balassa, 1971; Kruger, 1978; Bhagwati, 1978). The poor performance of developing countries that pursued import substitution policy was the starting point of rejecting the ISI strategy as a means of development, as the growth of per capita income in most developing countries pursuing ISI strategy was low, if not negative. Other countries, which managed to attain some economic growth, still lagged far behind the developed countries (e.g. Mexico). In contrast, the East Asian countries, which had deviated from ISI strategy, succeeded in narrowing the gap between themselves and developed nations.

The main reason for the failure of ISI strategy is the fact that "the infant industry argument was not as universally valid as many people assumed" (Krugman, 1992, p 267). Other than protecting domestic industries there are a number of factors, which determine the comparative advantage in manufacturing sector. The lack of human capital, infrastructure problems, managerial competence, and so on play a crucial role in the development of the economy. Imposing high tariff rates cannot improve the efficiency of poorly organised industry. The infant industry argument, which gives protection to domestic manufacturers for a period of learning and searching, has failed to deliver improvement in the performance of the developing countries.

Following the failure of ISI strategy in generating economic growth in the developing countries, researchers started to study the costs of these policies. Effective rates of protection (ERP), which was formally introduced by Corden (1966), made it possible to measure the distortions caused by import substitution policy. Although a number of studies provided persuasive evidence against ISI policy, there are still many developing countries that pursue import substitution strategy believing that it is a way forward for better economic performance.

2.5 Policy Reforms in Developing Countries

The debt crisis unleashed in the 1980s played a key role in instigating a critical examination of the policies in developing countries regarding the strategies towards long-run growth. Economists along with policy makers observed that inward-oriented policies, which were pursued by the majority of developing countries, were not the way forward for development or sustainable economy. The poor performance of the African, and majority of the Asian and Latin American countries provided a dramatic contrast to a rapidly growing and sustainable economic development of the East Asian countries. The disparities in the economic performance gave an agenda to economists as well as politicians to debate about the policies of developing countries.

During the 1980s economists began recommending, with much persistence, outward oriented policy, which is associated with a massive reduction of trade barriers, and devaluation of the foreign exchange rate. It was during this period that the World Bank and International Monetary Fund began to disburse financial assistance based on the Structural Adjustment programmes. Outward orientation and trade liberalisation were at the centre of the policy reforms in developing countries, and most of the policy reforms in these countries were instigated by the Bank's Structural Adjustment Loans (SALs). Outward orientation and trade liberalisation served as conditionality criteria for granting loans to developing countries. A number of authors (e.g. Thomas et al, 1991; Corbo and Rojas, 1992; Mosley et al, 1991) provided a thorough analysis on the role played by the Bank in the policy reform of the developing countries. According to Thomas et al (1991) the objectives of SALs are to generate stable macroeconomic conditions and to correct microeconomic distortions.

The poor performance of developing countries that implemented import-substitution (or inward-oriented policy) and the increasing empirical evidence in favour of outward oriented policy gradually provided a formidable case for policy reforms in developing countries. The success of the East Asian countries, which have pursued market-oriented policies, strengthened the proposition, which advocates openness as a strategy for development. There are three basic arguments in favour of outward oriented policy: (i) trade liberalisation has static effects as it reduces resource misallocation; (ii) openness to trade increases capabilities of countries to cope with external shocks; (iii) trade liberalisation enhances the process of adopting new technological advances (and consequently increases economic growth). The empirical findings in support of this argument are discussed in chapter 3. Let's now turn to discuss the recently developed trade models.

2.6 Trade and Growth in Endogenous Growth Model

There has been much discussion in the last few years concerning the ameliorating effect of trade on economic growth. The main catalyst for the resurgence of this topic has been the emergence of growth models that endogenise the growth process, and in so doing, have created frameworks that enable an analysis of the growth effects of a host of policy instruments. Endogenous growth models emphasise that long run growth rates are not pinned by a forever diminishing marginal productivity of capital, and can be affected by government policy (Lucas, 1988; Romer, 1986). Endogenous growth is obtained by allowing non-decreasing returns to reproducible assets, such as knowledge and human capital. The debate on the relationship between international trade and economic growth has been reignited following the birth of new growth models, which endogenise technological innovation. This section focuses on the theoretical studies of international trade and growth.

2.6.1 International trade and growth with physical capital accumulation

First, consider the impact of trade on growth that is driven by physical capital accumulation. There has been relatively little study in this area, although Jones and Manuelli (1990) studied trade and growth in an AK model with infinitely lived agents. They explore that trade policies that have an impact on the rate of return to capital have an effect on rate of growth. Rebelo (1991) has also used an infinitely lived model to show that differences in policies create growth disparities across countries. The study focuses on the impact of taxation on the rate of growth by assuming that its effect is suggestive of the impact of other policies (such as trade policy). The study explores how taxation (government policy) has an impact on the rate of growth through its effect on capital accumulation. It provides a model, which suggests that countries with distortionary trade policies should have low growth rates.

Fisher (1995) extends the two-sector AK model of Jones and Manuelli (1990) and Rebelo (1991) to an overlapping-generations model. A two-sector economy is considered (with a consumer goods producer sector and an investment goods producer sector). Individuals live for two periods, inherit nothing when born except being endowed with one unit of labour, and leave no bequest when dead. Each individual works, saves, and consumes only when young, and consumes only when old. Thus, in this model, saving of the economy comes entirely from workers when they are young and population and labour force are assumed to be constant over time.

2.6.2 Trade and Growth with Human Capital accumulation and Learning by Doing

In his two-sector model of accidental learning by doing, Lucas (1988) analyses the role of human capital in international trade and hence to growth. The model assumes that workers accumulate (accrue) knowledge through their experience at work. That is, they don't choose firms in order to learn or accumulate human capital; instead they accrue human capital by accidental learning by doing. The model considers two consumption goods and one factor of production (labour), and consumers are assumed to have homothetic preferences. Assuming Ricardian type of technologies in which the output of a good is determined by the efficiency of labour input, the production function of good i can be written as:

$$c_i(t) = h_i(t)\, u_i(t)\, N(t), \qquad i = 1, 2 \tag{2.1}$$

where $h_i(t)$ denotes human capital experience accumulated in the production of good i, $u_i(t)$ is the fraction of labour input allotted for the production of good i and $N_i(t)$ represents the total workforce in the economy.

Assuming human capital stock is a positive function of accumulated experience or the time devoted to producing good i, we can then write this relationship as:

$$\dot{h}_i(t) = h_i(t)\, \delta_i u_i(t) \tag{2.2}$$

Suppose that $\delta_1 > \delta_2$, i.e., sector 1 is the high-technology intensive good sector, while sector 2 is low-technology intensive good sector. Since Ricardian type of technologies are assumed in which output of a good is proportional to the efficiency units of the labour factor, in the absence of physical capital, the marginal product of labour in sector i. In the case when both types of goods are produced, the production function given in (2.1) plus profit maximisation implies that the price ratio is determined by human capital endowments.

In the context of a dynamic model for a closed economy to diversify between the two sectors, the two types of human capital should grow proportionally, i.e., $\delta_1 u_1(t) = \delta_2 u_2(t)$. Note here that because of the endogeniety of the technological factor, the autarkic relative price is determined by the level of technology and consumption preference of the economy. The steady state situation for the price ratio is determined by the elasticity of substitution between the two goods. If the two goods are close substitutes and a country tends to produce more of a good in which it is initially better, the steady state with diversification of producing both goods is unstable. If, on the other hand, the two goods are poor substitutes, the steady-state tends to be stable in producing both goods and hence the two sectors, ($\delta_1 u_1 = \delta_2 u_2$). The critical value of the elasticity of substitution is unity in the case when there are CES preferences.

In an extension of the above model, Lucas (1993) examines the impact of trade on the productivities of small economies. In this model the world price is exogenously determined and the comparative advantage of a country depends on the relative autarkic price. The model emphasises that countries tend to completely specialise in a good they have comparative advantage under autarky. Under free trade these countries will accumulate only the type of human capital that is distinct to the type of good they produce. Thus, under free trade the disparities in the type of goods produced between countries will generate growth rates differential.

Some compelling policy inferences can be drawn from the model discussed above. Suppose country i has long-run comparative advantage in the high-technology intensive good. Before the country opens up to trade, i.e., under autarky, the country is assumed to show a short-run comparative advantage in the low-technology intensive good. If this country pursues outward-oriented trade policy, it will export low technology good and turn out to be completely specialised in this good. The appropriate trade policy for this country is to pursue restrictive trade measures at the beginning and stabilise the economy towards the steady-state condition. The country can then adopt free trade policy after it achieves a comparative advantage in a good that tends to grow faster.

Using a similar approach of accidental learning by doing, Young (1991) examines the dynamic effect of international trade on growth. He explores that under free trade less developed countries experience lower growth rates than they enjoy under autarky. The stagnant growth rate of LDCs is the result of the static comparative advantage, which makes LDCs to specialise in primary goods. However, the less developed country can grow faster than the developed country if the initial knowledge gap between the two countries is small and the less developed country has higher labour input (human capital). The above analysis shows that learning is an increasing function of scale of production. The model implies that the short-term government subsidies to high-technology industries may lead the economy to acquire a competitive upper hand over its rival and hence it will give the country a permanent and increasing technical advantage.

Extending Young's model, Chuang (1998) provides a rigorous analysis on the effect of trade on growth, and the evolution of trade pattern. The model emphasises that both imports and exports play a crucial role in the learning process along with the trading partner of the host country. The model explores that the nature of traded goods have an effect on the learning process. The trade-induced technology transfer will also be determined by the effect on the level of technology from which one can learn.

Stokey (1991) has developed a model of growth that allows heterogeneity of the labour force, which is differentiated by the level of human capital, determines comparative advantage of the country. The model distinguishes between the individual human capital and the stock of knowledge of the society. Individuals accumulate human capital by investing in schooling and their level of human capital is determined by the length of time they spend at school. Individual's decision on investment in schooling has an effect on the growth of the social stock of knowledge. The model considers a continuum of goods produced that are different in quality, where high quality goods are produced by workers with higher stock of human capital. In a stationary growth path, human capital and the quality of consumption goods grow at the same rate. The model shows that if the country is less developed under autarky, implementing free trade policy may slow the rate at which human capital is accumulated, through its impact on investment in human capital accumulation. Under free trade, since high-skilled labour is relatively abundant in the rest of the world, the price of goods produced by highly skilled labour will reduce, which consequently affect the incentive to invest on accumulation of human capital. Thus, in the long run the developing country may lag behind the rest of the world in terms of human capital. This does not necessarily mean that free trade is harmful to developing countries, as the static gains from trade may outweigh the loss caused by the slower growth rate of human capital. In another study, Findlay and Kierzkowski (1993) developed a two-sector, two-country model of trade to show that human capital accumulation determines comparative advantage of a country. The model emphasises that the decision made on human capital (i.e., investment on schooling) affects economic growth. This implies that free trade has an impact on growth through its effect on incentives in accumulation of human capital.

Using the factor-price-equalisation theorem with Ramsey economic growth model, Ventura (1997) shows that capital accumulation is the source of economic growth. By allowing for measures of education and government policies, the model illustrates that more open economies tend to grow faster than closed economies. The model emphasises that countries are interdependent and it is the differential in rate of returns to capital that explain the differences in rate of growth across countries. According to this model, holding differences in labour productivity constant, developing countries tend to grow faster than developed countries if and only if factor prices do not change as fast as the growth of the world economy. Under autarky, marginal product of capital is inversely related to capital accumulation, because of the intensive use of capital. In the case of a small open economy, its marginal product is determined by the world's capital stock. This is simply because that goods are exported at the world price. The increase in stock of capital induces the country to produce and export more capital intensive good, which implies that the country can evade diminishing returns even in the case when its technology would not support sustained growth. This concept led Ventura to suggest that the East Asian success is the result of a large amount of capital accumulation without facing a significant fall in the marginal product of capital.

Van and Wan (1996) examine the relationship between knowledge spillover through learning by doing and trade using the theoretical framework developed by Findlay (1978). They explore the complementarity between technological progress, free trade and factor accumulation in the process of economic growth. This implies that free trade facilitates conditions through which an economy can learn from other economies.

2.6.3 Trade and Growth with Technological Progress

Technological progress occurs in three basic forms: either through innovation or development of new goods, improved factor productivity, or development of better quality goods. The cogency of investment in technology as a means of reaping economic returns draws upon, and is consistent with the assumption of the literature on international trade and economic growth. Suppose there are two countries who are technologically identical and both are at their steady state growth paths. Assume international trade to take place in two different conditions: (1) as a result of international patent protection, we assume there is no knowledge spillover through trade; (2) there is perfect knowledge spillover. In general, trade is assumed to take place either in goods only, where there is no knowledge spillover, or in ideas where there is perfect knowledge spillover.

In the knowledge driven models (KD) (such as, River-Batiz and Romer, 1991a; and Grossman and Helpman, 1991) the growth rate of innovation of new products determine the growth rate of the economy. The growth rate of innovation in turn is determines by the prevailing knowledge base and by the scale of employment in the R&D sector. Thus, the rate of growth of each economy is determined by the existing knowledge or by labour force allocated to R&D sector. In the absence of trade in ideas (no knowledge spillover) the knowledge base of each country remains unchanged. It is thus the increase in the scale of employment in the R&D sector that can generate new ideas and hence higher economic growth. In the absence of free trade the amount of capital goods employed in the manufacturing sector must equal the amount produced domestically. Under free trade the number of machinery and equipment employed in each country approaches twice the amount, which has been used before free trade. In the long run the researchers in the two countries specialise in different types of designs and duplication of innovated goods will be avoided leading to double the worldwide stock of capital goods. The increase in the availability of more capital goods in the manufacturing sector raises the marginal productivity of human capital in this sector.

Under free trade, the market size for newly developed products is twice as large as it has been before trade. Consequently, the price of the patents and the return to investment in human capital will be twice as high. As the returns to human capital in both manufacturing and R&D sectors double, the scale of employment will not be affected by free trade in goods. Thus, free trade in goods does not affect the balanced growth rate of the economy.

Now, consider the case in which trade in ideas is allowed. R&D activities are determined by the total worldwide stock of ideas. If the ideas between the two trading countries are nonintersecting, under free trade knowledge spillover doubles the stock of knowledge that can be used in the R&D sector. The availability of more ideas in the research sector increases the marginal productivity of human capital in R&D sector without affecting the productivity of human capital in manufacturing sector. As a result of the increase in the profitability of the R&D sector, firms will shift more human capital from the manufacturing sector. This implies that the two countries experience higher growth rates under free trade in ideas (Rivera-Batiz and Romer, 1991a).

Rivera-Batiz and Romer (1991a) have also developed a lab equipment model of research that shows that the current stock of knowledge does not have an impact on the rate of innovation of new products. This implies that knowledge spillover has no economic effect. However, free trade in goods has a positive impact on the growth of the economy as a result of the increase in the profitability of the research activities.[2]

In another influential paper, Rivera-Batiz and Romer (1991b) consider three sectors in their knowledge driven model: agricultural sector, manufacturing sector, and the R&D sector. The agricultural sector produces unskilled intensive goods, while manufacturing sector is intensive in skilled labour. The R&D sector uses skilled labour and specialises in inventing intermediate products. As Etchier (1992) noted, the availability of a wider range of intermediate goods will lower the costs in the manufacturing sectors. The profitability of producing these intermediate goods determines the rate at which new goods are produced, and hence the rate of the fall in the manufacturing costs. It can then be suggested here that the R&D sector is the source of the economic growth, as activity in this sector directly determines the rate of growth of the economy.

Many studies have not paid much attention to the stability of the steady state with some exceptions, e.g., Devereux and Lapham (1994), who examine the knowledge driven model of River-Batiz and Romer (1991a). They show that the results in this model can only hold if and only if the knowledge base are exactly equal across countries pre-liberalisation. They demonstrate trade only in goods (i.e., no flows of ideas) will cause economic growth provided the two countries have different levels of income. They explore that a country with a higher initial stock of knowledge will devote more human capital to R&D sector when opening up to trade.

Grossman and Helpman (1991, ch 8) have developed a model of trade in which knowledge spillover is permitted. The trading countries are assumed to produce a homogenous good horizontally differentiated products using a single factor of production

[2] In the knowledge driven model free trade in goods increases the size of the market, which in turn raises the profitability of the R&D sector. However, the number of employment will not be altered since the marginal productivity of human capital in manufacturing sector is offset by the positive of the research sector.

(labour). New designs and equipments are developed in the R&D sector before they are used in the manufacturing sector. A unit of labour is assumed to produce a unit of traditional product or high-tech good, or to expand the set of producible varieties by the stock of knowledge capital per unit of time. The traditional good is produced in the country with lowest production cost. In this model each country's stock of knowledge corresponds with their own research activities. Moreover, there are different steady state equilibria: first, if country A has a higher market share for high-tech goods and the production cost of traditional goods is the same in both countries, R&D activity is assumed to take place only in country A, while traditional goods are produced in both countries. In the second steady-state condition one country specialises in R&D while the other is focusing on the production of traditional goods. This requires the cost of production of traditional goods in country B is less than or equal to the cost of production in country A.

In analysing the impact of human capital, Romer (1990) has developed a model which shows knowledge spillovers effect of trade and hence the effect of trade to growth. The model emphasises that integrating with human capital rich country has a positive impact on growth. Employing the same model, Grossman and Helpman (1990) show that under certain conditions trade restrictions could enhance the rate of growth. The model emphasises that the impact of trade policy on growth depends on its effect on the amount of resource (human capital) devoted to the R&D activity. Consider a two-country world (say A and B), and suppose country A has comparative advantage in high-tech or newly developed goods (i.e., R&D sector). If country B imposes a tariff on exports from country A, there will be a resources (labour) shift to R&D sector in country B, which in turn leads to an increase in its rate of growth. Similarly, in the presence of knowledge spillovers, an R&D subsidy imposed by country B could have a negative impact on the rate of growth of both countries. This is simply because of the fact that more resources will be shifted from manufacturing sector to R&D sector, causing resource scarcity in the manufacturing sector. This may hamper the export sector in country A by encouraging country B's exports and discouraging country A's exports. Consequently, the R&D subsidy tends to have a negative impact on the world's rate of growth.

In their classic study of the impact of trade restrictions on growth, Rivera-Batiz and Romer (1991b) consider two identical countries producing heterogeneous input goods. Three basic trade effects are analysed in this study: First, trade has an integration effect between identical sectors in different countries. The integration effect arises if the sectors exhibit increasing returns to scale that could occur as a result of knowledge spillover or monopolistic competition between the firms across the countries producing a variety of intermediate goods. Thus, trade enhances worldwide output growth as a result of the integration between the two firms across the countries.

The second effect of free trade is the "allocation effect", which is associated with the changes in the sectoral production as a result of reallocation of factors between sectors. Free trade induces countries to reallocate their basic factors toward the sector in which they have a comparative advantage. Factor endowments or the level of technology determine the allocation effect of trade. Finally, trade restrictions may result in a redundancy effect as a result of producing and inventing the same intermediate goods in both countries.

The model considers two symmetric countries that impose tariffs on all imported intermediate goods. In the absence of trade all domestically produced intermediate goods are assumed to be identical to the amount that is being used. Let τ be the rate of tariff imposed by the domestic government, thus the price of the imported good is $(1+\tau)$ times the price paid to foreign exporter. Tariffs have adverse effect on the demand for foreign goods implying that tariffs determine the degree of integration in the manufacturing sector, but not in the research sector (since innovation will not be affected by tariff). The only effect of a tariff is its effect on resource allocation, i.e., it induces shifting resources between manufacturing and research sectors. The results in this model suggest that the level of human capital employed in R&D sector is a non-monotonic function of the tariff rate and hence growth rate.

The model shows that for all values of τ greater than zero, the growth rate will be less than the rate of growth without tariffs. The model indicates two effects of tariff: a distortionary effect and a resource allocation effect. The increase in the tariff rates affects the returns to human capital in both R&D and manufacturing sectors. The adverse effect of tariff on newly developed imported goods arises as a result of their high prices. This effect may result a shift in resources from the R&D sector. However, an increase in the tariff rate also affects the amount of imported intermediate goods, which in turn affects the marginal productivity of human capital in the manufacturing sector. Therefore, the size of tariff determines the relative strength between the two sectors.

Following Grossman and Helpman (1991 ch 9) and Rivera-Batiz and Romer (1991a), we can draw the impact of trade as follows:

(i) Resource allocation effect: Static comparative advantage determines the movement of resources from one sector to another as the country opens up for trade. If the impact of such movement is to direct resources to more productive or growth-enhancing sector of the economy, the impact of trade is to stimulate economic growth; otherwise, opening to trade may be futile for growth. In the context of the models sketched by Grossman and Helpman (1991) and Rivera-Batiz and Romer (1991a), a country, which is not well endowed with human capital, would experience a fall in rewards to skilled labour and underfunded in undertaking R&D. This has a consequent effect on the growth of the economy. On the other hand, as Grossman and Helpman (1991 ch 6) show, if the country is well endowed with human capital it would experience increases in skilled wages and hence a decline in growth rates. In general, international trade may enhance economic growth to the extent that R&D activity is more closely associated to the exporting sector than the import-competing sector.

(ii) The effect of trade on the market size: International trade expands the size of the market, and it has both positive and negative effects. The positive effect comes from the increase in the returns to the R&D sector as a result of market expansion. For example, the increase in the market size provides a range of intermediate goods at lower costs, which consequently enhance R&D activities and economic growth. Alternatively, as Davis (1991) noted, larger market sizes speed up the rate of learning when there is learning by doing activities. The other effect of the expansion in the market size is the increase in competition faced by the home firms. Feenstra (1990) provides a model of two countries with unequal sizes in which intermediate goods are not traded. The absence of trading in intermediate goods implies that

the smaller country has a cost disadvantage in producing these goods, and firms of this country will face low market share in international market. The consequent effect of this low market share is to lower the economic growth of the smaller country.
(iii) Avoidance of duplication: In the absence of international trade, different countries may engage in the same type of innovative activities. Trade can avoid such duplication of developing identical products.

Up to this point we only have considered horizontal innovation in the analysis of trade under technological improvement. We now turn to the issue of vertical innovation. Grossman and Helpman (1991) developed a model of vertical innovation, which consists of two basic factors, skilled labour (H) and unskilled labour (L). The model considers vertically differentiated goods (x) and the outside goods (y). Vertically differentiated goods use only skilled labour while outside goods use both primary factors, although they employ unskilled labour intensively. The model suggests that skilled labour abundant home country specialises in vertically differentiated goods, implying that foreign country imports good x. Thus, under free trade foreign country will be a net exporter of outside goods. The model shows that, depending on the elasticity of substitution in the production of the outside goods (y) free trade generates higher growth rates. If the elasticity of substitution is greater than unity, there will be more skilled labour available for R&D sector, and also the increase in unskilled labour results higher relative wage ratio between the two factors, leading to a shift in the skilled labour to R&D sector from outside goods sector. If, on the other hand, the elasticity of substitution is less than one, there will be scarce skilled labour in the R&D sector resulting in a slow rate of growth.

Taylor (1993) examines issues related to trade patterns and specialisation with vertical innovation. He generalises the Grossman-Helpman quality-ladder model by allowing asymmetry among the continuum of goods. Under the Ricardian technology, the interaction between the comparative advantage rankings in production and in innovation determines the long-run pattern of trade. Succar (1987) provides a formal analysis of the process of technological assimilation of developing country and emphasised the technical complementarity between capital and technical capabilities in the research sector to shift outwards the achievable production function of modern sector. Dollar, Wolff and Baumol (1988) contend that trade between countries acts as a conduit for dissemination of knowledge. Thus, to the extent that is true, the erection of barriers to trade inhibits the transmission of ideas and prevents countries from attaining levels of wealth that might otherwise be possible.

2.6.4 Knowledge Spillover

In the preceding section we discussed two key issues concerning knowledge spillover across countries. The first one is costless and direct technological transfer; and the second one refers to the case in which there is no technological transfer. These are two polar cases, but the real world lies in between the two cases. Newly developed goods or designs share some of public good properties, such as non-excludability and non-rivalness. Once they are introduced to the world, other firms could adopt them either in the same country or abroad. The adoption of the new technology by other firms does not alter its utilisation of the new technology. However, if the newly developed technology is highly sophisticated and generates improved factor productivity or better quality good, the firm would like to be the sole user of the technology and seeks to prevent others from adopting while the others are attempting to imitate.

Here, we want to draw attention to the analysis of knowledge spillover across countries assuming perfect domestic protection of new technology. In the analysis of knowledge spillover three basic issues come to light: (1) costs of imitating the technology by the developing countries from developed nations; (2) the relevant features of the product cycle hypotheses; and (3) government policies, such as R&D subsidies and intellectual property rights protection, that have direct impact on the rate of innovation and imitation. All of the above the issues are linked to each other and here we discuss these issues briefly.

The product-cycle hypothesis provides a thorough analysis on the issue of invention and production of new products in high-income countries[3], and later production shifts to countries with lower wage rates. Posner (1961) was the first to provide an analysis of the significance of imitation and innovation processes in determining the pattern of trade between countries. His model shows that trade between countries arises as a result of technological innovation that determines the competitiveness of these industries. The relative cost of imitation, that depends on the available resources (human capital), determine the time taken to adopt newly developed technology. Vernon (1966) examines the role of imitation and innovation in the process of development, and discusses the factors that determine innovation and imitation process. Assuming that high volume of new ideas emerge from USA, the model also considers a dynamic process to explain how newly developed goods are frequently innovated in USA and then imitated by the European and other developing countries. Vernon's model emphasises that foreign direct investment (i.e., the investment of US firms abroad) is the main channel through which technology transfer takes place.

Vernon's product cycle theory has been extended and formalised by many other studies. Krugman's (1979) North-South model provides a rigorous analysis of innovation and imitation. The model considers two-country world, named North and South. The North is considered to be highly advanced and all technologically advanced goods are assumed to be innovated and produced in this country before they become imitated by the South, which is technologically less advanced. The newly developed goods are exported by the North to the South, but once the South imitates them they become 'old goods', which then exported by the South to the North. Both innovation and imitation are continual processes indicating the dynamic characteristic of pattern of trade. Labour is assumed to be the only factor of production in each country. There are a continuum of products that are categorised as old goods and new goods. New goods can only be produced in the North while the old goods can be produced in either the North or the South. In this model the pattern of trade is determined by the product innovation. Changes in the composition of trade is determined by the rate of innovation and rate of imitation. The welfare aspect in these countries depends on the rate of

[3]Most literature use USA as a prime example of high-income country.

innovation and rate of imitation. Faster rate of innovation by the advanced country and/or slower imitation by the less advanced country means that larger income of advanced country. It is thus, the monopoly power over a new product that determines the reward to labour (wage) in advanced country. This indicates that knowledge spillover narrows the wage differential between the advanced and less advanced countries.

Assuming that the rate of technology transfer to the less developed country is positively related to differences in production costs between the advanced and less-advanced countries, Dollar (1986) has extended Krugman's model by considering capital as additional factor of production. Furthermore, capital is assumed to move between countries in response to return to capital disparities across countries. The model considers that imitation is an increasing function of North-South wage gap, which reflects the monopoly characteristic of the North on innovation. Two fundamental conclusions can be drawn from this study: (1) For factor prices and the terms of trade to be stable, there must be a stable ratio of the number of goods produced in each developed and less developed countries; (2) The model divides the world economy in which the pattern of trade remains the same (i.e., the North always innovates and produces 'new goods' while the South specialises in the 'old goods'. The endogeniety character of the model arises following the assumption that innovation, imitation and capital mobility are determined by the differences in the cost production across the countries. This implies that level of technology and capital endowments of a country will be as much as a result of trade.

Feenstra and Judd (1982) also adopted Krugman's model and examine several welfare and policy issues. They considered labour as the sole factor of production, and it is assumed to be equally efficient in producing commodities but has different efficiency in the R&D sector. The model explores that the relative cost determines the pattern of trade such that the technologically advanced country specialises in R&D or exporting technology while less developed country exporting all other goods.

In a somewhat different model Jensen and Thursby (1986) considered the notion of cost on both imitation and innovation processes. As in the case of other studies discussed above, innovation is assumed to take place in the advanced country (North). The stocks of newly developed products and old goods (those whose production technology is known across the countries) are determined by the rate of innovation and technology transfer. The rate of innovation is determined by existing number of goods and the labour input in the R&D sector. The pattern of trade is determined by the profit maximisation behaviour of firms in both countries. The study examines the steady state open-loop Nash equilibrium of a game in which a Northern monopolist and a Southern planner choose the rate of innovation and technology transfer. What distinguishes this model from other product-cycle models is that the game theoretic approach allows analysis of how innovation and technology transfer are strategically related in a dynamic framework. Given resource costs, neither the Northern monopolist nor the Southern planner wants to alter the technology gap.

Elkan (1995) developed a model of an open economy in which the stock of human capital may be augmented by either imitation or innovation. In this model, the initial level of stock of human capital determines the productivity of imitation, while productivity in innovation is determined by the past behaviour through learning by doing. Technological improvement generates higher rates of growth and income levels in both trading countries. A country with low level of human capital follows a dynamic path, which is characterised by a shift towards innovation as the knowledge gap (stock of human capital) narrows. Developing countries tend to grow faster than developed nations when they engage in international trade. Elkan (1996) extended his earlier study by allowing incomplete specialisation. The model assumes that every country has the ability to acquire human capital through both imitation and innovation. The model explores how productivity in innovation is directly linked to level of stock of human capital, while productivity in imitation is determined by the knowledge gap.

2.7 International Trade, Foreign Direct Investment and Knowledge Spillover

It is well known that multinational firms are concentrated in industries that exhibit a high ratio of R&D relative to sales and a large share of technical and professional workers (Markusen, 1995). In fact, it is commonly argued that, multinationals rely heavily on tangible assets such as high technology to successfully compete with domestic firms who are well established in the host country environment.

By encouraging FDI, developing countries hope not only to import more efficient foreign technologies but also to generate technological spillovers for domestic firms. It has been argued that exposure to the superior technology of multinational firms may lead domestic firms to update their own production techniques. The main point here is that, in the absence of FDI, it may simply be too costly for local firms to acquire the necessary information for adopting new technologies if they are not first introduced in the local economy by multinationals. There are two basic channels of knowledge spillovers: (1) demonstration effects: domestic firms may adopt technologies introduced by multinational firms through imitation or reverse engineering; (2) labour turnover: workers trained or previously employed by the multinational may transfer important information to local firms by switching employers or may contribute to technology diffusion by starting their own firms (Keller, 1998; Markussen and Venables, 1999; and Saggi, 1999).

Dinopoulos, Oehmke and Segerstrom (1993) have developed a dynamic general equilibrium model of international R&D competition in which lower quality goods are replaced by better quality ones. In this model production activities follow the traditional Heckscher-Ohlin trade model, where pattern of intersectoral trade is determined by factor endowments. They analyse the pattern of trade and investment in a steady state equilibrium in which R&D expenditures and the rate of product innovation are constant over time. Differences in factor endowments determine the extent of intersectoral trade and multinational activities. These activities can take the form of multinational plant manufacturing, single plant manufacturing in one country with R&D research in another, or licensing of manufacturing of newly developed products. When there is no patent protection R&D activities will stop, the model generates the traditional Hecksher-Ohlin model of international trade at each point in time.

The demonstration effect argument relates well to the point made by Parente and Prescott (1994) that trade may lower costs of technology adoption. Clearly, geographical proximity is a vital part of the demonstration effect argument. The main insight of the demonstration effect argument is that FDI may expand the set of technologies available to local firms. If this is the case, it implies a potential positive externality effect. However, since a mere expansion in choices need not imply faster technology adoption, especially if incentives for adoption are also altered due to the impact of FDI on domestic market structure. FDI may expand choices but it generally also increases competition. The net effect on the incentives for adopting new technologies may be ambiguous (Parente and Prescott, 1994; and Pack and Saggi, 1997).

FDI is assumed to be one of the vehicles for knowledge spillovers between countries. It lowers the cost of technology adoption and leads to faster adoption of newly invented technologies by domestic firms. Does this scenario imply FDI, relative to trade in goods, generates greater knowledge spillover? We need to point out here that foreign firms will face more, perhaps, severe competition as a result of faster technology spillover. To prevent this foreign investors may alter the very terms of their original technology transfer. For example, a foreign firm may choose to transfer technologies that are low in quality when there is a risk of adoption of the technology by local firms. However, it is conceivable due to their larger size and other advantages they enjoy in the product market, multinationals can change the market outcome in their favour despite technology leakage or adoption. For example, Das (1987) developed a model in which native firms may learn from the subsidiary of a multinational firm who acts as a dominant firm facing a local competitive firm in the good market.

Wang and Blomstrom (1992) present a duopoly model with differentiated goods that shows a multinational transfers technology to its subsidiary given that the local firm can learn from the new technologies introduced. Learning occurs both through costless technology spillovers (as in the contagion effects first noted by Findlay, 1978) as well as through costly investments made by the local firm. The most interesting implication of the model is that technology transfer through FDI is positively related to the level of the local firm's learning investment.

2.8 Conclusions

This chapter presents a review of the literature that deal with the relationship between trade and growth. As discussed earlier, the Ricardian model of comparative advantage deals with the static gains of international trade but not its impact on growth. The dynamic version of Ricardian model was discussed by Findlay (1984), but he also could not provide unambiguous results regarding the link between trade and growth. In fact, according to his model trade can hurt growth.

The new endogenous growth models and new trade theory also fail to provide clear results regarding openness and economic growth. According to the new trade theory, international trade is better than interventionism since interventionism in trade leads to non-market failures that could hurt growth. This chapter has reviewed the major issues of international trade and economic growth. We began by discussing the type of trade policy, which is commonly implemented in developing countries, and we analysed why developing countries need to reform their policies.

Endogenising and exploring growth of the economies has become the main focus in the recent literature. We have attempted to narrow our analysis by focusing on the literature which is concerned with the link of economic growth with particular features of the models such as preferences, technologies, and government policies. Different factors that stimulate growth have been outlined: accumulation of capital, learning by doing, education and R&D.

In the past few decades countries show wide disparities in their growth rates, and it is interesting to investigate why different growth rates occur. The neoclassical model of Solow and Swan is not the appropriate vehicle for the simple reason that it implies that countries with identical and fixed technologies and preferences will converge in terms of their growth rates until they reach the steady state with same (exogenous) growth. On the other hand, researchers are interested examining the implications of various government policies on growth, which is still not compatible with neoclassical model.

The importance of endogenous growth model lies in successfully isolating the determinants of economic growth. We have highlighted the important factors that may affect the growth of an economy. The more practical implication of these models is that the government has a role to play in affecting economic growth. The literature on trade and growth, with its diversity of results (as we will see in Chapter 3), suggest that no simple policy recommendations should be made without a thorough understanding of the structure and the key features of the economies under consideration. The results and the relationship between international trade and economic growth in general are sensitive to the structure of the economic models. According to Rivera-Batiz and Romer (1993) opening to trade will raise economic growth, whereas it will be retarded according to Young (1991).

It is indisputable that the endogenous growth literature has improved our understanding of some of the factors that affect economic growth of a country. Despite the voluminous literature of the last few years, there remain several unanswered questions. It does seem to us, when one deals with openness and growth, it is important to consider a country's level of development (explained by it human capital endowment and quality of infrastructure) which gives a basis to examine the link between international trade and growth. Human capital is essential in determining the absorptive capacity of the country, and good quality of infrastructure is believed to attract foreign investors through which knowledge transfer takes place. There are, then, distinct policy prescription to be drawn in relation to trade and growth. Thus, it is important to bear in mind the stages of development aspect of countries. For instance, outward-orientated or import substitution industrialisation policies can be good for some countries but ineffective for others.

CHAPTER 3

Empirical Studies in Trade and Growth: A Survey

3.1 Introduction

Despite a voluminous literature, employing different empirical methods and producing many empirical studies using cross-country data sets, there is still considerable controversy on the issue of the relationship between international trade and economic growth. A number of reasons can be noted for the divergence in views between different authors. One reason is related to the way the researchers define the issue being analysed. For example, some authors consider the causality issue between growth in trade and growth of the economy, while others are interested in examining the impact of trade policy on economic growth. Furthermore, the manner in which openness is defined also has significant consequences on one's conclusion from the study's sample countries. Differences in sampling and quantity and quality of data are important factors in determining the findings.

This chapter presents an in-depth survey of the empirical literature concerning the relationship between international trade and economic growth and evaluates how far the existing empirical evidence supports the currently popular view of economists and policy makers that the relatively more open economies tend to grow faster than the relatively less open ones. We analyse the methodology, the techniques employed in the literature, and the conclusions that emerged in these studies. This chapter presents an intricate analysis of the empirical studies, aiming to provide extensive knowledge of the issues surrounding international trade and economic growth.

3.2 Cost of Import-substitution Policies

3.2.1 Measuring cost of protection

The concept of effective rate of protection, which is defined as the proportional increase in the value added per unit relative to free trade, was formally introduced by Balassa (1965) and Johnson (1965). Extending the earlier work, Corden (1966) provides a model that is intended to capture the impact of protection measures in a given industry.[1] The effective rate of protection is determined by the tariffs levied on the final goods as well as the intermediate goods.

A number of studies provided extensive explanation on the efficiency cost of import substitution policies (Little et al, 1970; Balassa, 1971; Bhagwati, 1978; and Krueger, 1978). Little et al (1970) and Balassa (1971) provide pioneering studies in analysing the impact of trade policies on economic performance of developing countries. These studies examine the effect of trade policies (which mainly include trade protection and industrial regulation) on the structure of the economy. Eight developing countries are included in Little et al study, namely, Argentina, Brazil, Mexico, India, Pakistan, Philippines, and Taiwan. Balassa, on the other hand, dealt with Brazil, Chile, Malaysia, Mexico, Pakistan, Philippines, and Norway.

Using the effective rate of protection (ERP), Little et al (1970) and Balassa (1971) provided significant empirical studies on the relationship between trade orientation and economic performance in developing countries. The empirical results suggest that the extent of protection on manufacturing value added was higher than what the nominal rate of protection (tariff rates) indicates. The calculated figures show that there was a strong tendency to discriminate in favour of manufacturing sector at the expense of the rest of the economy, particularly the agriculture sector.

In Balassa's study, with the exception of Brazil and Norway, the rest of the countries exhibited a discriminatory policy against the agricultural sector. This biased protection policy creates the opportunity for the manufacturing sector to expand at the cost of the primary sector. In addition to this, as Balassa noted, the monopoly characteristic of the protected industries will result in the redistribution of incomes from consumers to the producers

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[1] The effective rate of protection of an industry j is given by:

$\varepsilon_t = \dfrac{v_j - v_j^*}{v_j} = \dfrac{[p_j - \Sigma_i p_i a_{ij}] - [p_j^* - \Sigma_i p_i a_{ij}]}{p_j^* - \Sigma_i p_i a_{ij}} = \dfrac{t_j - \Sigma_i a_{ij} t_i}{1 - \Sigma_i a_{ij}}$, where v_j is value added per unit of good j in the presence of tariff; v_j^* is value added per unit of good j under free trade; a_{ij} is the amount of good i required to produce one unit of good j; p_i is domestic price of good i; p_i^* is world price for good i; and t_j is tariff on good j.

through its higher costs effect. Furthermore, protection will tend to have further adverse effects leading firms to follow a policy of low turn over and high profit rates and have little incentives for production improvement and technical change.

According to Little et al. (1970) and Balassa (1971) the remedies for poor economic performance in developing countries is to reduce the extent of protection. These studies provided a great deal of empirical evidence in favour of outward-oriented policy. Nevertheless, these were controversial for a few obvious reasons: (1) Although both Little et al. and Balassa used the same ERP formula derived by Corden (1966), they find different figures for the same country in the same period (e.g. the ERP to the manufacturing sector in Philippines in 1965, Little et al. computed an ERP of 49 percent while Balassa came up to 61 percent), (2) neither of the two studies attempt to analyse the alternative trade regimes before they recommend outward-oriented as a better policy instrument.

Krueger (1978) and Bhagwati (1978) were the first to provide a formal classification of trade regimes in which they defined trade orientation based on its biasedness towards exports. The degree of biasedness against export is indexed by the ratio of the effective exchange rate on exports (EER_x) to that on imports (EER_m)[2]. Therefore, if EER_x/EER_m is less than one for a given commodity, it indicates the existence of a bias against exports. A unitary value, on the other hand, shows the existence of neutral trade regime, while a value of greater than unity indicates that the country is pursuing outward-oriented trade policy.

3.2.2 Import-substitution and unemployment

Grossman (1986) studied the impact of protectionism on employment in USA and his empirical results show that tariff protection has significant effect on employment of some sectors, while wages are found to be unresponsive to import prices. These findings led Grossman to suggest that there is high intersectoral labour mobility within USA as a result of low wage elasticity and high employment elasticity. Revenga (1992) and Trefler (1993) have

[2] Effective exchange rate (EER) is the exchange rate of a country's currency measured by reference to a weighted average of the exchange rates of the currencies of the country's trading partners (i.e., $EER=w_1R_1+w_2R_2+\ldots+w_nR_n$). This implies that if R_2 is relatively unimportant, as, for example, the French frank is to the Indian trade-weighted index, then the weight w_2 will be small.

also found that changes in import competition have a significant effect on inter-sectoral change in employment. These studies show that trade policy changes in USA and Canada result in employment reallocation between industries.

So little has been done to investigate the impact of trade policy on employment for developing countries. In the study, which was sponsored by NBER, Krueger (1983) studied the impact of trade on employment of nine developing countries. This study mainly focused on 1) measuring the intensity of labour factor in the exportable goods sector and import competing sector and 2) measuring the degree of the impact of protectionism in shifting towards capital intensive manufacturing sector. Currie and Harrison (1997) used a similar approach as Grossman (1986) to analyse the impact of trade liberalisation on employment in Morocco. Using plant-level data for a period of 1984-1990 they found that the impact of tariff reduction and elimination of quotas have no significant impact on employment in most of manufacturing firms. However, employment in the traditional industrial sector, such as textiles, beverages and apparel, have been found to be responsive to trade reforms. That is, a 21-point decline in the protective measures was associated with a 6 percent fall in the employment of these sectors.

3.2.3 Import-substitution and resource allocation

Import-substitution policies provided incentives for the development of high cost industries without taking into consideration the increase in the long-term productivity of these industries. These policies led to the separation of the traditional pattern of comparative advantage and specialisation. One of the consequences of import-substitution is its effect on resource allocation through its negative impact on the exports sector, agriculture, employment and newcomers in industry.

Although the degree of implementation differs, the basic feature of the industrialisation strategy in developing countries is designed to encourage manufacturing sector by facilitating conditions that will cause the terms of trade and income distribution in favour of manufacture and against agriculture. The studies indicate that all the countries considered followed import substitution that created a substantial increase in the prices of manufactures relative to agricultural prices. This shift in the terms of trade and income distribution has made agriculture less attractive in terms of both labour and capital, which consequently led to a migration of people from rural farming areas to urban centres (Little, Scitovsky and Scott, 1971; and Balassa, 1970). Furthermore, a large proportion of investment funds is allocated to the manufacturing sector rather than to the agricultural sector.

Policies of industrialisation have created huge income disparities between manufacturing and agriculture sectors. Relatively higher income generated by urban employment creates incentives for migration of population towards the urban centres and consequently creating urban unemployment. As Little et al (1971) noted, between 1950-1960 urban population of developing countries increased at an average annual rate of 4.6 percent which is one-third faster than the 3.5 percent annual increase in industrial sector employment. It has also been observed that import substitution affected the allocation of investment funds and hence employment within the manufacturing sector, favouring import competing production than exportable; and complex over traditional industries.

The impact of trade policies which discourages both the imports and exports sector has been well analysed by Svedberg (1991) in examining the dismal export performance of sub-Saharan Africa (SSA). Policies that are anti-imports (which are mainly industrial and investment goods, input goods and fuels) have seriously hampered capacity utilisation and economic growth, which in turn affects exports negatively. It has been argued that one of the main reasons for the poor performance of exports in SSA is that there is excessive import protection and overvalued exchange rates as well as high taxes on exports which discourage domestic exporters.

Svedberg's statistical analysis shows that the share of exports of SSA in the world market was 3 percent in the 1950s, which then declined to the level of 1.2 percent by 1987. During 1970s SSA's share of non-oil exports accounted for 16 percent of the world market which subsequently declined to 5 percent by late 1980s. Exports of manufactured goods remained to be trivial at 6 percent of total SSA exports during 1970-1987. In addition to the decline in the barter terms of trade for SSA exports, high taxes levied on international trade (imports and exports) overvalued exchange rates contributed significantly to the decline in the total income terms of trade.

Although a number of studies put forward both theoretical arguments and empirical evidence that import substitution is less economical in respect of resource allocation, the magnitude of these costs has not been dealt with satisfactorily. Srinivasan and Whalley (1986) show that the welfare cost of relative price distortions is very small percentage points of GNP. Romer and Jones (1991), on the other hand, show that as the distortions get larger, parallel and black market tend to raise the welfare costs. These findings raise an important question: if the price distortion impact is too small in terms of welfare costs, what is it then that creates a large performance gap between the inward-oriented economies and outward-oriented economies? The answer lies beyond the impact on static allocative efficiency.

3.3 Measuring Openness

One of the problems of analysing the relationship between trade orientation and economic growth is that openness does not have a universally accepted definition derived from theory. As a result, quite a large number of studies have come out proposing and computing alternative measures to capture the concept of openness. Following Baldwin (1989) and Pritchett (1996), there are three basic strands to the literature.

The first strand associates economic growth with the ex-post measures of openness, such as ratio of exports to GDP or rate of growth of exports [e.g. Balassa (1982), Feder (1983), and Haiso (1987)]. While it is a useful approach, export performance itself is not necessarily an indicator of the openness of trade policy. That is, export shares are also determined by other factors, such as country size, geography and location. At the same time, it is problematic if export performance is itself endogenous.

The second strand attempts to evaluate openness using an outcome-based approach. This approach assesses the deviation of the actual outcome from what the outcome would have been without the trade barriers. There are two most frequently used outcome-based measures. One is a trade flow measure based on the residuals from a trade intensity ratio [TIR $= \Sigma_j(X_j - M_j)/GNP$] regression. This measure shows the amount by which a country's trade intensity differs from that predicted for a country with similar characteristics which is sometimes augmented with a modified Hecksher-Ohlin-Vanek (HOV) model of trade flows [e.g. Leamer (1988)].

As we will use this indicator in our further empirical analysis in the forthcoming chapter, we discuss, briefly, Leamer's (1988) openness measure. Let N_{ij} be the value of net exports and $N_{ij}^{*} = \beta_j^{\prime} v_i$ be the predicted value of N_i, where v_i is vector of factor supply and β is a vector of parameters depending on tastes, technologies, and prices. N_{ij} is obtained by regressing the following trade intensity equation:

$$\pi_{ij} T_{ij} = \{\Sigma_f [\delta_{jf} w_{if} v_{if} / w_{wf}] + \Sigma_f [\gamma_{jf} v_{if} (1 + \tau_i)]\} / (1 + \tau_{ij}), \tag{3.1}$$

where $\pi_{ij} T_{ij}$ is the value of net exports of commodity j by country i, τ_{ij} is the tariff barrier on commodity j in country i, w_{if} is the internal reward to factor f in country i, v_{if} is the supply of factor f in country i, τ_i is the tariff average, and δ_{if} and γ_{if} are taste and technology parameters, which are assumed to be constant across countries. The objective of the estimation is to use observations on the value of trade and supply of factors to infer the unobservable (residuals) variables reflecting trade barriers. Thus, the measure of openness is given as the adjusted trade intensity ratio:

$$TIR_i = [\Sigma_j (N_{ij}) - \Sigma_j (N_{ij}^{*})] / GNP, \tag{3.2}$$

where N^{*} is the trade predicted by the model. The adjusted trade intensity ratio is the actual minus the predicted trade intensity ratio. If the actual is higher than the predicted the country is considered to be open and closed otherwise.

Trade intervention indices computed by Leamer (1988) are obtained by using the cross-country factor endowments model (HOV) and the degree of government intervention. In general, they measure the restrictiveness of trade regimes. However, the ranking of countries in Leamer's study has serious limitations. For example, the openness measure computed from residuals of heteroschedastic trade models ranks Ivory Coast and Morocco ahead of USA. These anomalies were criticised by Rodrik (1993) by noting that "such irregularity shows that the basic method used in the construction of the indices is inadequate and perhaps lead to biased results (p. 15)". Based on this irregularity Leamer himself doubted the applicability of the indices and noted, " as I examine these results, I am left with a feeling of scepticism regarding the usefulness of the adjusted trade intensity ratios as indicators of trade barriers" (1988, pp 198).

The third strand is that the incidence-based approach which measures openness by direct observation of trade measures and has been used in numerous other studies, such as Balassa (1985), World Bank (1987), Dollar (1992), and Leamer (1988). Sachs and Warner (1995) computed binary measure of openness, which falls into this category, and it is a fairly comprehensive measure of the major types of trade restriction. Countries that are considered to be open take a value of 1 and 0 if they are closed. Average tariff rates and non-tariff barriers are direct obstacles to imports of goods and services. Black market premia are measures of exchange control. A large premium is evidence of the rationing of foreign exchange, which can prevent the free flow of both goods and capital and studies have found a significant negative correlation between growth and black market premia (e.g. Harrison, 1996). The dummy variables for socialist economic systems and state monopolies on exports are used to cover countries that limit openness directly by central planning rather than by the types of price and quantity control already mentioned. Although incidence-based measures may still be endogenous (given, for example, the interaction between political economy and economic performance) they are likely to be less endogenous than other measures of openness.

The World Bank (1987) classified trade orientation of countries by combining the following quantitative and qualitative indicators: (1) Effective rate of protection (ERP): higher average rate of effective protection implies greater bias to import substitution. (2) Direct controls: quotas and import licensing strategies reflect more inward oriented trade policy. (3) Export incentives: availability of incentives to export implies more of outward oriented economy. (4) Exchange rate alignment: the greater the extent of exchange rate overvaluation, the greater the likelihood that the economy is inward oriented.[3]

Using the information collected from 1963 to 1985 a sample of 41 countries were divided into four categories: (A1) Strongly outward-oriented: in this category it is assumed that there are no trade barriers or they are at minimal. Export disincentives are more or less counterbalanced by export incentives; there is little or no use of direct controls; and the exchange rate is maintained. (A2) Moderately outward-oriented: the overall incentive structure is biased toward production for domestic rather than export markets, but the average rate of protection is relatively low; there is limited use of direct controls; there is provision of some incentives to export; and the effective exchange rate is higher for imports than exports. (B1) Moderately inward-oriented: the overall incentive is in favour of production for the domestic market accompanied by a relatively higher average rate of effective protection (for home market); extensive use of direct import controls. Some direct incentives to exports may be provided, but there is a distinct anti-export bias, and there is overvalued exchange rate. (B2) Strongly inward-oriented: the overall incentive structure is strongly in favour of production for domestic market. There is a very high average effective rate of protection; excessive use of direct controls; disincentive to traditional exports; few or no positive incentives to non-traditional exportables; and there is a significant overvaluation of the exchange rate.

3.4 Trade Policy and Growth of Industrial Productivity

3.4.1 Empirical studies on infant industries

Several studies focused on empirical tests of the infant industry hypothesis. An important study by Krueger and Tuncer (1982a) examines sectoral TFP growth rates of the Turkish industries. Of the 16 industries 9 of them are regarded as import substitution sectors, while the other 7 are regarded as traditional sectors. The comparative analysis of the effective rate of protection (ERP), and domestic resources cost (DRC) with rates of growth of output

[3] Earlier studies have also used similar indicators to determine trade orientation (Krueger, 1978; Donges, 1975; and Agarwala, 1983)

per unit of input, suggest that industries which were protected during 1960s (under the import substitution industrialisation strategy of Turkish policy) did not have higher TFP growth rates than less protected traditional sectors. The analysis has only focused on what has happened during the period of protection. The variation in TFP of these protected industries has not been examined in the absence of protection, which of course might give a different picture than is reported.

Drawing data on the automobile sector of four countries - Argentina, Mexico, Korea and Canada - Waverman and Murphy (1992) analysed the impact of trade policy on TFP growth of automobile industries. The results suggest that Argentina is found to be the second of the four countries to exhibit a high TFP growth rate during the 1970s when Argentina is considered to be a highly closed economy. However, it has also been observed that the TFP growth rate in Argentina was also high during the period of free trade regime (1978-1981). Following these findings, the authors conclude that openness has not provided a significant contribution to TFP growth in Argentina.

Bell et al (1984) provided a statistical report on the performance of infant industries. The report suggests that infant industries protection was not up to its expectation as the evidence reveals a dismal productivity growth such that infant industries have failed to acquire international competitiveness.

3.4.2 Empirical tests on industrial productivity

Several studies provided empirical evidence that some trade policy variables are correlated with changes in industrial productivity. Krueger and Tuncer (1982b), for example, estimated total factor productivity of Turkish industries against trade policy variables for the period 1963-1976. The estimated results suggest that slower productivity growth coincided with periods in which there were stringent trade policies. During the study period the Turkish government implemented various types of measures as incentives for the private manufacturing sector to achieve the goals of import-substitution industrialisation. These incentives included inward oriented trade policy for activities that are aimed to replace imported goods. Import licensing was the main instrument used to prevent imported goods that might compete with domestic production.

Total factor productivity (TFP) rates of growth were estimated for a period of 13 years (1963-1976), and also since there have been trade regime changes during the study period the authors divided it into four sub-periods: The first period which runs from 1963-1967 was characterised by relative ease of the import licensing system, while sub-period 2, from 1967-1970, was one of the restrictive trade regime. The third sub-period, from 1970-1973 is characterised by relative ease of import licensing following the devaluation of foreign exchange. In the fourth sub period, from 1973-1976, there was high degree of difficulties in obtaining import licenses and anti export regime.

Krueger and Tuncer (1982b) econometrically tested two hypotheses: (1) moving towards import-substitution and the increasing cost of stringent trade policy would have caused a decline in total factor productivity growth, and (2) the more restrictive the trade regime is the lower the productivity growth in the classified sub-periods. The results show that the average rate of total factor productivity growth declined from the average rate of 3.2 percent between 1963 - 67 to an average of 1.31% during 1967-1970, which then rose to 2.51% over the period of 1970-1973 before it fell to -1.18% during 1973-1976. These findings support the hypotheses that the sub-periods that are characterised by import stringency (1967-1970 and 1973-1976) are associated with lower productivity growth rates.

Drawing data for semi-industrial countries (Korea, Turkey and Yugoslavia, and Japan as a comparator) Nishimizu and Robinson (1984) analyse the impact of trade policies on sectoral total factor productivity growth of the manufacturing sector. Three hypotheses were tested: (1) a positive link between higher export expansion or increased import substitution and TFP growth, through their effect on increasing market size; (2) a positive link between higher exports and TFP growth, negative (positive) correlation between TFP growth and import substitution (liberalisation), arising from competitive cost-reducing incentives or lack thereof, and (3) a positive link between export expansion, import liberalisation, and TFP growth, arising from the importance of foreign exchange constraint and non-substitutable imports of intermediate inputs and capital goods. The following equation was estimated:

$$\mathrm{TFPG} = \beta_0 + \beta_{EE} X_{EE} + \beta_{IS} X_{IS} + \varepsilon, \tag{3.3}$$

where TFPG, X_{EE}, and X_{IS} are, respectively, annual rates of TFP growth, output growth allocated to export expansion, and output growth allocated to import substitution (i.e., supply response in terms of TFP changes to changes in export expansion and import-substitution), and ε is an error term. Thirteen different manufacturing industries were included in the study for which a regression test was done to examine the impact of trade policy on TFP growth of each industry. The overall regression results suggest that a significant proportion of the variation in TFP growth rates was explained by output growth allocated to export expansion and import substitution for Korea, Turkey and Yugoslavia, but not in Japan. Of the total of 28 cases, which were statistically significant elasticity with respect to export expansion, only two were negative, whereas in the case of import substitution of the 21 cases 13 of them were found to be negative. These findings imply that export expansion seem to be positively correlated to TFP growth, whereas import substitution is negatively correlated to TFP growth. Nishimizu and Robinson (1984) have noted, however, that there is no causality attributed to these empirical findings.

Nishimizu and Page (1991) included a number of industries from various countries in their regression analysis. The results support their hypotheses that exports growth is positively correlated to TFP growth. However, their findings show that these results correspond only to the countries that pursued market-oriented policies. They also obtained another empirical result, which suggests that import penetration is negatively correlated with TFP growth in the same countries after the oil price shock period of 1973. Nevertheless, as in the case of previous studies, the direction of causality is not examined or known. Lee (1992), on the other hand, focuses on the productivity consequences of Korea's industrial policy. The study includes a panel of 38 Korean manufacturing sectors for 1963-1983. The econometric results suggest that sectoral TFP growth rates are negatively correlated with non-tariff barriers, and positively correlated with tax incentives.

3.4.3 Trade and technological innovation at firms' level

Focusing on Indian enterprises, Katrak (1989) also investigates the impact of openness on the domestic technological performance (R&D activity). The econometric test, which included 300 enterprises for the period 1980-1984 shows that there is a positive relationship between the number of imported technology and domestic R&D activity in Indian enterprises.

Other empirical studies on how trade policy affect domestic technological performance include Prasnikar et al (1992), and Aitkin and Harrison (1992). The Prasnikar et al study (which uses panel data of 120 Yugoslavia industrial enterprises form 1975 to 1979) finds no evidence to suggest that export orientation or the presence of joint ventures with foreigners had positive effects on technical efficiency. Along similar lines, Aitkin and Harrison (1992) have examined the impact of the presence of foreign firm(s) on the performance of domestic firms productivity of Venezuela. The empirical results show that there is no indication that the productivity of domestically owned firms has improved as a result of the presence of foreign firms.

Chen and Tang (1987) produced an important paper, which avoids some of these problems. Their study, which compares levels of technical efficiency[4] of Taiwan's electronics industry, divides 184 firms that are restricted to export all of their outputs, and the other group comprises of firms that are allowed to provide their output for protected domestic markets (local market oriented firms). The empirical results suggest that export oriented firms, which have less capital-labour ratio than local market oriented firms exhibit higher technical efficiency.

3.5 Time-series and Cross-Country Studies

Several empirical studies use cross-country analysis to determine the impact of trade policy on growth. A variety of trade policy measurements are used to link it to growth. But finding an appropriate measure of trade policy has never been easy nor free of criticisms. Although most of the earlier empirical studies show that openness has positive impact on

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[4] A production method is technically inefficient if, to produce a given output, it uses more of some inputs and no less of other inputs than some other method that could be used to produce the same output.

economic growth, there was no firm theoretical analysis that links trade policy to long run economic growth. The new growth theory, as pioneered by Romer (1986) and Lucas (1988), endogenises technological change and is capable of explaining the effects of policy changes on growth. There are two ways in which the analytical problems of trade policy have been examined: first, it is argued that a movement from one steady state to another could account for most growth effects of domestic policies; and second, it is argued that free trade has long run effect on productivity and growth.

3.5.1 Openness and growth (exports as a measure of openness)

In the study, which was organised by the NBER, Krueger (1978) and Bhagwati (1978) examined the impact of trade on growth. In their studies trade regime is delineated into five phases in terms of movements from import-substitution to outward-orientation policies: phase I is characterised by imposition of quantitative controls and it is mainly associated with unsustainable balance of payments problems. In phase II quantitative restriction becomes more complex and discriminatory with an intense characteristic of anti export trade policy. Phase III is characterised by relaxation of some of the restrictions and implementation of devaluation. This is in general the phase in which trade begins to be liberalised. During phase IV there is a continued process of liberalisation with a substantial decline in import premium and elimination of anti export measures. In phase V the economy is fully liberalised as there is full convertibility on current account and quantitative restrictions are not implemented any more.

Their studies examined particular episodes of inward-oriented and outward-oriented trade policy. In addition to changes in import protection and export subsidisation, Krueger (1978) and Bhagwati (1978) consider a range of macroeconomic policies implemented by the governments, such as monetary and fiscal policies, especially exchange rate policy which favours import substitution strategy.

Two hypotheses have been postulated by Krueger to test the effect of trade on the economic growth developing countries: (1) trade liberalisation will lead to a higher rate of growth of export; and (2) trade liberalisation has a positive impact on aggregate growth.[5] Krueger (1978) has laid out the direct and indirect impact of trade liberalisation. The direct effect of free trade is its impact on resource allocation to more efficient and sophisticated investment projects. The indirect effect of liberalisation is through its impact on the growth of exports, which in turn has an impact on GNP.

Using pooled data Krueger estimated the following two equations for both traditional and non-traditional exports:

$$\log X_{it} = a_{0i} + g \log REERX_{it} + rT_t + a_1 d_1 T_1 + a_2 d_2 T_t + a_3 d_1 + a_4 d_2 + \upsilon_{it} , \tag{3.4}$$

where X_{it} are either traditional or non-traditional exports in country i in period t; $REERX$ denotes exports effective real exchange rate; T_t is a linear trend; d_i is a dummy that takes the value of one in phases I and II and zero otherwise; and d_2 is a dummy that takes the value of one in phases IV or V, and zero otherwise.

A real GNP equation was also estimated using time series data for each country in the study;

$$\log GNP_t = b_0 + b_1 T_t + b_2 \log X_t + b_3 d_1 T_t + b_4 d_2 T_t + \varepsilon_t , \tag{3.5}$$

where X_t is an index of the dollar value of exports of country i at time t, relative to i's average exports over the entire period.

The regression results suggest that devaluing the exchange rate has a positive effect on non-traditional exports; but traditional exports have been found to be insensitive to changes in the real exchange rate. The coefficient of d_2 for both traditional and non-traditional exports was positive and statistically significant, which implies that more liberalised trade policy has a positive impact on exports growth. These empirical findings led Krueger to suggest that real exchange rate changes have more relevance to exports growth than the evolution of trade liberalisation process through time. The estimated results for the real GNP equation show that

[5] Krueger and Bhagwati defined trade liberalisation as a process of moving away from anti-export bias policies.

the coefficients of the dummy variables were not significant at a conventional level, implying that trade liberalisation does not have a direct impact on growth.

Krueger's conclusion that trade policies do not have direct impact on growth has been strongly criticised by Balassa (1982). He noted that Krueger's econometric results were affected by the way trade policies have been classified. Furthermore, he argued that the impact of tariff, which has a negative impact on exports has been ignored in the study. In his classic paper Balassa (1982) delineated trade regimes into four phases rather than five, as in the NBER study. According Balassa's classification, outward orientation policy implies that both QRs and tariffs would be eliminated in contrast to the inward oriented regime where there is strong bias against exports. Eleven countries (Brazil, Chile, Colombia, India, Israel, Korea, Mexico, Singapore, Taiwan, and Yugoslavia) were included in the study for a period of 14 years, i.e., from 1960-1973. These countries were divided into four categories based on the data on effective rates of protection, effective export subsidies, and nominal protection. The empirical results suggest that countries with lower anti-export policies have experienced higher rates of growth of exports. Based on these empirical findings Balassa argued that protectionism has a strong negative impact on exports growth. Furthermore, Balassa uses the growth rate of exports, as a proxy for trade policy orientation, to test his hypothesis, which emphasises that trade policy has an impact on economic (GDP) growth independent of exports. The empirical results, obtained using the Spearman rank correlation coefficient, suggests that export growth has a positive correlation with output growth. Based on these findings, Balassa concludes that "the expansion of exports and consequent growth of GNP have been the result of the incentives applied" (1982, p. 59). However plausible this study might look, it has some limitations. For example, the effect of the real exchange rate on the rates of growth of exports is ignored, the use of export growth as a proxy for trade policy orientation and the study does not have a profound analysis on the causality effect between exports and economic growth.

Balassa (1978) uses pooled data for a sample of 11 countries for the period 1960-1973, and he finds that there is a significant and positive relationship between export expansion and economic growth as posited by pro-free trade economists emphasising outward orientation policies for developing countries. Of the eleven countries in the sample, Korea and Taiwan showed high performance while India and Chile demonstrated poor performance. Such sample choice would give strong evidence in support of the free trade hypothesis. However, it is far from robust as empirical evidence, because such statistical analyses have to be generalised to hold for a lager sample of developing countries.

Michaely et al (1989) also use a similar method of classification of trade policies and use dummy variables to capture the effects of various trade regimes on economic performance. The estimated results suggest that countries with a highly liberalised trade regime performed better than countries with a less liberalised regime. Nevertheless, as in the case of previous studies, defining and measuring trade orientation seems to be arbitrary. The study does not provide a clear cut of classification in to which countries can be categorised as weak or strong trade liberisers. Moreover, the effect of different degree of liberalisation on economic performance is restricted by using the binary dummy variables.

The studies we have surveyed so far are vulnerable to criticisms on various grounds. For example, none of them have not given adequate explanation on the issue of causality effect, as the studies focus on regressing a growth variable on a contemporaneous export variable.

Most of the 1960s and 1970s empirical studies on trade and growth used the Spearman rank correlation method. Since this method can only show the relationship between the two variables, it is not possible to determine the impact of other variables. To resolve this problem a number of economists used an analytical production function framework. Feder (1983) was the first economist to provide a formal production function model to evaluate the impact of exports on growth. The major development of his work is the derivation of a growth equation as a function of two sectors: exports and nonexports sectors. According to Feder, there are two ways through which exports affect output growth. First, the exports sector is assumed to generate a positive externality to the nonexport sector via its effect on a better management skills and efficient production techniques. Second, there is a productivity differential in favour of the exports sector, i.e., through its effect on reallocation of resources from the less efficient non-export sector to the higher productive export sector. In other words, expanding the export sector has a positive impact on growth at the expense of the nonexport sector. Feder (1983) posited his theoretical approach in a simple model where he assumed the economy to have two sectors, the exports sector and nonexport sector, with outputs X and N, respectively (a full analysis of Feder's (1983) model is presented in Chapter 5).

The estimated results can be summarised in the following equation form:

$$g_y = \underset{(0.180)}{0.002} + \underset{(3.542)}{0.178} I/Y + \underset{(2.802)}{0.747} \dot{L}/L + \underset{(5.454)}{0.422} (X/Y)(\dot{X}/X) \tag{3.6}$$

$R^2 = 0.689$ Figures in parentheses are t-values.

where I/Y is ratio of investment to GDP, $\dot{L}/L$ is rate of growth of labour and $(X/Y)(\dot{X}/X)$ is ratio of export to GDP multiplied by the growth rate of export (which enters in the regression as openness variable). The coefficient of $(X/Y)(\dot{X}/X)$ is positive and statistically significant as expected. The investment ratio has also a positive sign and its magnitude is within the expected range. From the estimated results Feder concludes that there is a "strong support to the hypothesis that marginal factor productivities in the export sector are higher than in the non-export sector" (p. 65).

A number of authors have extended Feder's work in different ways. Ram (1985), for example, includes exports as a factor of production along with labour and capital, and also he uses the growth rate of export as the openness related regressor instead of the product of ratio of export to GDP and growth rate of export as in the case of Feder's model. He uses a sample of 73 developing countries in his cross-section empirical study for the period 1960-1977. The export variable has a positive coefficient, which is statistically significant, and thus supporting the hypothesis that export has a positive impact on growth. A further study by Ram (1987) also reaffirms this finding. However, the channel through which the export affects growth is not being specified. It has only been considered an export nexus in the analysis.

The majority of cross-country studies provide evidence, which favours outward-oriented policies over import substitution policies [Balassa, 1978 and 1985; Tyler, 1985; Feder, 1983; Kavoussi, 1984; Ram, 1985 and 1987; Nishimizu and Robinson, 1984; and many others]. The fundamental emphasis of these studies is that export oriented trade policies are associated with higher exports growth, which in turn generate higher economic growth. With the exception of Krueger (1978) and Agarwala (1983), the other of earlier studies (reviewed in this chapter) use the rate of export growth as a proxy for openness.[6] The positive correlation between export growth and output growth has been interpreted as strong evidence in support of export oriented trade policy over import substitution strategies. However, time series studies by Donges and Riedel (1977) which included 12 countries obtained results, which only partially support the export oriented hypothesis (that is, the time series results of only seven countries support the hypothesis). In four countries out of a sample of 12, the movement towards export-oriented policy was followed by a fall in the pattern of rate of export growth, while the positive result for the fifth country was not statistically significant.

Using the framework of an endogenous growth model, Easterly (1992) examined the effect of openness on economic growth. The cross-section regression analysis includes up to 70 developing countries over a period of 1965-1988. Using the OLS the following results were obtained:

$$Y6588 = \underset{(-0.383)}{-0.701} + \underset{(2.556)}{0.229}\,IY6588 + \underset{(2.902)}{1.013}\,LFORCE + \underset{(2.440)}{0.053}\,DIFEXP - \underset{(-2.073)}{0.124}\,GY6588 - \underset{(-1.667)}{1.315}\,LADUM$$
$$-\underset{(-1.559)}{1.050}\,AFDUM$$
$$R^2 = 0.386 \qquad DW = 1.58$$
$$\bar{R}^2 = 0.327 \qquad F = 6.51 \qquad N = 70$$

Figures in parentheses are t-values. (3.7)

where *Y6588* is the rate of growth of gross output, *IY6588* is ratio of investment to GDP, *LFORCE* is the growth rate of labour force, *DIFEXP* is changes in the share of exports in GDP, *GY6588* is the share of government consumption in GDP, LADUM is a dummy

[6] Krueger uses qualitative assessments of trade regimes along with export volume, to explain the level of GNP. Agrawala, on the other hand, uses output growth as an independent variable and protection level of manufacturing and distortion of

variable for Latin America and AFDUM is a dummy variable for AFRICA. The export share variable is assumed to measure the trade orientation of the country (i.e., whether open or closed). The results show that export variable which is used here as an openness index has a positive effect on growth, while government consumption has a significant negative impact on growth.

Having noted that export share cannot be taken as an indicator of trade policy (import distortion), the author used dummy variables for countries which are classified by the World Bank (1987) as inward oriented. A dummy variable for countries with distortionary controls on interest rate was also employed. Countries where real interest rates were less than 5 percent are defined as countries having distortionary controls on interest rate. The two stage least square regression result is as follows:

$$Y6588 = \underset{(2.422)}{3.611} + \underset{(4.789)}{0.183}\,IY6588 + \underset{(0.757)}{0.245}\,LFORCE - \underset{(-1.97)}{0.175}\,GY6588 - \underset{(-3.310)}{1.546}\,TDUM - \underset{(-3.413)}{1.712}\,FDUM$$

$$R^2 = 0.816 \qquad F = 15.085 \qquad (3.8)$$

$$\bar{R}^2 = 0.762 \qquad N = 23$$

Figures in parentheses are t-values.

The results show that the dummy variables used for trade policy distortions (*TDUM*) and financial policy distortions (*FDUM*) are negative and statistically significant, implying that, on average, these two variables cause a decline in the rate of growth by about 1.5 percentage points.

Extending Feder's (1983) production function framework, the model considers both exports and industrialisation as additional factors of production along with capital and labour.

$$Q = f(L, K, X, R), \qquad (3.9)$$

where Q is real GDP, L is labour, K is capital, while X and R are real value of exports and an index of real industrial production, respectively. Totally differentiating the above equation with respect to each variable yields:

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exchange rates as regressors (proxies for trade policies)

$$\frac{dQ}{Q}=\frac{\partial Q/Q}{\partial L/L}\frac{dL}{L}+\frac{\partial Q/Q}{\partial K/K}\frac{dK}{K}+\frac{\partial Q/Q}{\partial X/X}\frac{dX}{X}+\frac{\partial Q/Q}{\partial R/R}\frac{dR}{R} \tag{3.10}$$

or in its simplified form:

$\tilde{Q}=a+b\tilde{L}+c\tilde{K}+g\tilde{X}+h\tilde{R}$, where ~ indicates their rate of growth while b, c, g, and h measure the output elasticity of L, K, X, and R, respectively.

After dropping L as explanatory variable, and substituting Y and I for Q and K, respectively, the following equation is developed which is ready to be estimated:

$$\overline{Y}=a'+c'I+g'\overline{X}+h'\overline{R}, \tag{3.11}$$

where $\overline{Y}$ is the growth of real per capita income, I is ratio of gross fixed capital formation to GDP, $\overline{X}$ is the growth in the value of real exports, and $\overline{R}$ is the growth of real industrialisation, while c' measures the marginal physical product of capital, and g' and h' denote the export and industrialisation elasticity of per capita income, respectively.

The cross-country regression results show that, in contrast to the expectation, the export variable is highly significant for the strongly inward-oriented economies. The estimated equation for the outward-oriented countries is as follows:

$$Y=\underset{(0.14)}{0.88}+\underset{(0.44)}{0.13}I+\underset{(1.63)}{0.16}\tilde{X}-\underset{(-0.61)}{0.01}\tilde{R} \qquad R^2=0.05 \qquad DW=2.23 \qquad N=66 \tag{3.12}$$

Figures in parentheses are t-values

and for inward-oriented countries the OLS regression yields the following:

$$Y=-\underset{(-0.68)}{7.75}+\underset{(0.57)}{0.34}I+\underset{(4.96)}{0.10}\tilde{X}-\underset{(-0.72)}{0.02}\tilde{R} \qquad R^2=0.11 \qquad DW=2.04 \qquad N=22 \tag{3.13}$$

Figures in parentheses are t-values

In defence of these inconsistent results, the authors argue that "... for outward oriented countries, the main benefit from international trade comes not from trade itself but from the more efficient use of domestic resources that a more outward trade orientation fosters (p.15)".

The estimated coefficient on investment variable, on the other hand, is positive and statistically significant at the 10 percent level only for strongly outward oriented countries in both study periods and for moderately inward oriented countries in the second sub-period. For the remaining groups the investment variable has a negative coefficient, although it is statistically insignificant. The coefficient for industrialisation variable has a positive sign and statistically significant for all groups of countries in the second period except the strongly inward oriented countries, which has a negative coefficient although it is not statistically significant. These results led the authors to suggest that "industrialisation under a strongly inward orientation leads to serious inefficiencies that neutralises the positive contribution that industrialisation can potentially make to the growth of real per capita income and development". The estimated coefficient of industrialisation variable for the first period is statistically insignificant, supporting the view that most of the countries began liberalising their economies in the second period.

A further analysis, which involves time series data of each of the 26 countries for the entire period 1963-1985, was carried out by using an OLS method. The estimated results show that the coefficient of investment variable is positive and statistically significant at the 10 percent level for only five countries out of 25 (Korea, Singapore, Mexico, Philippines, and Yugoslavia). In the case of the sample of 19 inward-oriented countries, the estimated coefficient of the investment variable is not statistically significant supporting the hypothesis that strong inward orientation leads to less efficient use of resources. For the case of Peru and Tunisia, the estimated coefficient of investment variable is negative and statistically significant. Peru is categorised as one of the strongly inward oriented countries, while Tunisia is considered to have shifted to be moderately outward oriented in the second study period. Except in the case of Tunisia, the results of the remaining 6 countries support the hypothesis that strongly inward orientation leads to less efficient use of resources.

The export variable has a positive and statistically significant coefficient for 16 cases out of 26. In contrast to other studies, Singapore and Yugoslavia have negative and statistically significant coefficients on the export variable. Salvatore and Hatcher interpreted these findings by suggesting that international trade benefits a broad range of countries regardless of their trade strategy. Of 26 countries, 11 of them had a positive and statistically significant coefficient for investment variable. Out of 8 strongly inward oriented countries, only Zambia exhibited a positive and statistically significant coefficient of industrialisation supporting the view that industrialisation is important for development.

3.5.2 Trade liberalisation and economic growth (non-export measures of openness)

The studies we have reviewed so far have used the exports growth rate (some times weighted by export shares) as a proxy for openness. Since exports are part of GDP, using such indices results in biased results and limits the argument for openness for trade. The World Bank provided the first formal qualitative evaluation of trade orientation (TO) for 41 developing countries 1965-1973, and 1973-1984 (World Bank, 1987). Different types of quantitative and qualitative indicators have been considered in classifying countries into four categories ranging from strongly outward oriented to strongly inward-oriented.

Greenaway and Nam (1988) used the taxonomy constructed by World Bank (1987) to evaluate the impact of trade policy on the macroeconomic performance of developing countries. The study period is divided into two sub-periods, namely 1963-1973 and 1973-1985, following the fact that policies have been changed and world trade unsettled by the 1973 oil price shock. The comparative analysis shows that the average gross domestic savings rate which was recorded at 13 % in 1963 for strongly outward oriented countries has increased to 31.4 percent in 1985, whereas in countries with inward oriented policy the average gross domestic savings rate have shown a slight increase from 15 percent in 1963 to 17.9 in 1985. This figures has been interpreted as an implication of that outward oriented economies have been most successful in generating resources for investment activities. This suggestion is supported by the evidence that the annual average incremental capital output ratios (ICORs) of outward-oriented countries are lower for both sub-periods (2.5 in 1963-1973 and 4.5 during 1973-1985) in contrast to the inward-oriented countries (5.2 in 1963-1973 and 8.7 during 1973-1985). A further interpretation of these figures is that investible resources have been deployed more effectively in outward-oriented countries.

The real GDP figures show that the fastest growing economies are countries with outward oriented policies. The annual average growth rate of GDP of outward oriented countries between 1963-1973 was 9.5 percent, whereas inward-oriented countries grew by only 4.1 percent. During 1973 - 1985 the most outward oriented economies grew by 7.7 percent while the most inward oriented countries grew by 3.7 percent. Between 1965-1973 the annual average real growth rates for merchandise exports was higher in the moderately inward oriented countries with an average growth of 14.1 percent; the strongly outward-oriented with 10.8 percent; moderately outward-oriented with 8.8 percent; and strongly inward-oriented with 2.2 percent. However, the group average was higher in outward oriented with 9.4 percent, in contrast to 8.8 percent of inward-oriented economies average merchandise exports growth. Between 1973-1985 the A1 subgroup exports growth rate increased to 11.2 percent whilst there was a marginal fall in the A2 subgroup to 8.6 percent.

The exports growth of the B1 subgroup, in contrast, has fallen to 5.5 percent while there was a negative growth in the B2 subgroup. For outward-oriented countries the real GNP per capita grew by 6.9 percent during 1963-1973, whilst inward-oriented countries GNP grew by only 1.6 percent. Between 1973-1985 there was a 5.9 percent growth in the outward-oriented economies, while a negative growth of 0.1 percent was observed for inward-oriented economies. This comparative analysis led Greenaway and Nam (1988) to suggest that "outward orientation has been more conducive to growth and exporting than inward-orientation (p. 433)".

Extending Greenaway and Nam's work, Alam (1991) examined the relationship between trade orientation and growth rates of output and exports, and savings and investment rates by using simple regression analysis. The impact of trade policies and exports on total factor productive has also been tested using a production function framework. The regressions to be estimated are defined as: $y = \alpha + \beta(\text{TO})$, where TO is trade orientation, and y is an index of dependent variable: GY (growth of output), GX (growth of exports), S/Y (ratio of savings to output) and I/Y (ratio of investment to output). The estimated results show that there is a positive relationship between growth rates of output and outward orientation as the coefficients of TO, for both sub-periods 1963-1973 and 1973-1985, are positive and significant at 1 percent level.

$$GY = \underset{(2.3)}{1.74} + \underset{(5.7)}{1.94}\,TO \qquad R^2 = 0.45 \qquad F = 32.9 \qquad N = 41 \qquad (3.14)$$

$$GY = \underset{(0.9)}{0.64} + \underset{(5.1)}{1.64}\,TO \qquad R^2 = 0.42 \qquad F = 26.3 \qquad N = 38 \qquad (3.15)$$

Figures in parentheses are t-values.

Regressing export on trade orientation produces the following results:

$$Gx = -\underset{(2.5)}{4.39} + \underset{(6.1)}{4.63}\,TO \qquad R^2 = 0.50 \qquad F = 36.8 \qquad N = 39 \qquad (3.16)$$

$$GX = -\underset{(2.5)}{4.38} + \underset{(5.1)}{4.07}\,TO \qquad R^2\ 0.43 \qquad F = 26.3 \qquad N = 37 \qquad (3.17)$$

Figures in parentheses are t-values.

Rates of savings and investment have also been found to be positively related to trade orientation (TO). However, the correlation is much weaker than that of between TO and output growth rates.

To examine the impact of trade orientation (TO) on the growth of productivity, a further regression was computed by defining the estimated equation as follows:

$$GY = a + b\,(I/Y) + c\,GL + d\,GX + D^1 + D^2 + D^3, \qquad (3.18)$$

where GL is growth rates of labour force; D^1 is dummy variable which takes the value of 1 for moderately inward-oriented economies and zero otherwise; $D^2 = 1$ for moderately outward oriented economies and $D^2 = 0$ otherwise; and $D^3 = 1$ for strongly outward oriented economies and $D^3 = 0$ otherwise.

The estimated results, which are written below, suggest that export growth has a significant positive effect on GDP growth (in both sub-period tests).

$$GY = \underset{(1.0)}{1.25} + \underset{(1.8)}{0.71}\,GL + \underset{(1.6)}{5.38}\,I/Y + \underset{(5.5)}{0.28}\,GX \qquad (3.19)$$

Figures in parentheses are t-values.

The regression results, which included dummy variables, can be written as follows:

$$\underset{(1.8)}{GY = 2.37} + \underset{(0.4)}{0.21}\,GL + \underset{(1.3)}{4.99}\,I/Y + \underset{(1.7)}{1.45}\,D^1 + \underset{(3.4)}{3.23}\,D^2 + \underset{(3.7)}{5.66}\,D^3 \qquad \bar{R}^2 = 0.42 \tag{3.20}$$

Figures in parentheses are t-values.

F = 6.9
N = 41

$$GY = \underset{(0.6)}{-0.72} + \underset{(1.6)}{0.57}\,GL + \underset{(1.7)}{6.96}\,I/Y + \underset{(2.7)}{1.85}\,D^1 + \underset{(2.6)}{2.02}\,D^2 + \underset{(3.5)}{4.55}\,D^3 \qquad \bar{R}^2 = 0.47 \tag{3.21}$$

Figures in parentheses are t-values.

F = 9.0
N = 38

The regression results, which included the dummy variables, show that their coefficients have the expected signs and are statistically significant at the conventional level. Following these empirical findings Alam (1991) concluded that the study has established a strong positive correlation between outward-orientated trade policies and output growth rates across the sample of developing countries. However, as Alam admittedly noted, "it is not clear how these results are to be interpreted with respect to the direction of causation (p. 846)".

Cross section studies of the 1970s and 1980s focused on the relationship between exports and growth, and not on trade policy and growth. As Edwards (1993) noted, many of these studies failed to address the important issues, such as the mechanism through which exports growth affects economic growth and also the issue of other economic factors, such as education attainment or human capital, were not considered. By the late 1970s most economists began to subscribe the notion that export growth leads to faster economic growth without strong or concrete empirical evidence to support this contention.

There are a number of studies, which have provided evidence on the export-led growth hypotheses. Otani and Villanueve (1988), for example show that a 2 percentage point increase in the ratio of export to GDP generate a 4 - 5 percentage point increase in per capita

GDP growth. These studies examine the existence of positive correlation between exports expansion and economic growth, but the causality issue is not being dealt with directly.

Using time series data set, Wilburn and Hague (1991) provide a comparative analysis of six developed and eleven developing countries with respect to the direction and the extent of covariation between exports and gross domestic savings over a period of 1960-1988. They employ Maizel's (1968) theoretical approach by modifying it to fit their empirical analysis. They estimated two sets of equations:

$$\ln S_t = \alpha + \beta \ln Y_t + \mu_t \qquad (3.23)$$

$$\ln S_t = \alpha + \beta \ln(Y_t - X_t) + \gamma \ln X_t + \mu_t \qquad (3.24)$$

where $ln\ S_t$ represents the log of savings at time t, $ln\ Y$ is the log of GDP at time t, $ln\ X_t$ is the log of exports at time t, $ln\ (Y_t - X_t)$ is the log of non-export GDP (N_xGDP), and μ_t is the stochastic error term. The empirical results show that the gross GDP variable in equation 3.23 is not statistically significant for Costa Rica, Ecuador or Zaire; while it is highly significant for all developed countries. Except in the case of El Salvador, the non-export GDP variable in equation 3.24 is positive and statistically significant for all countries in the sample. The exports variable is found to be insignificant for four developing countries (Pakistan, Sri Lanka, Burma, and the Dominican Republic) and two developed countries (USA and Italy). Based on these findings the authors suggested that non-export GDP is a more reliable regressor than GDP and exports fostered economic growth, through its effect on savings and hence investment, in countries that had stable political situation.

The studies we have reviewed so far focus on the issue of the relationship between exports and economic growth. It is, however, widely recognised that the idea of export as an engine of economic growth still gives rise controversies, which lie mainly on the issue of measuring openness. The concept of openness is related primarily to trade policy. Several studies of the 1990s focused on using appropriate proxies for trade policy in analysing the impact of openness on growth. Lee (1993), for example, uses tariff rates and black market exchange rate premiums as indices for trade and exchange rate distortions, respectively. In his analysis of the link between trade and growth, he uses a neoclassical growth model where the domestic producers require both domestic and foreign intermediate input goods. The model shows that distortive trade policies lead countries to experience diverse rates of growth and per capita income in the long run. The empirical results support the hypothesis that trade distortion measures (such as tariff and black market premia) have a negative impact on the growth rate of per capita income. It also provides evidence that trade distortion measures generate cross-country differences in growth.

The estimated model postulates that per capita income is a function of initial income and trade distortions. To avoid the possible correlation between the error term and the distortion variables, the savings rate variable is included in the estimated equation. The growth equation then takes the form:

$$\begin{aligned}(1/T)\log[y(T)/y(0)] = C' &- (1-\alpha)(x+n+\delta)\log[\hat{y}(0)] + \alpha_k(x+n+\delta)\log S_k \\ &+\alpha_h(x+n+\delta)\log S_h + (x+n+\delta)\log(1+g) - (x+n+\delta)\pi\log(1+\tau) \\ &-(x+n+\delta)\pi\log(1+\omega\phi) + \varepsilon'\end{aligned} \tag{3.25}$$

where $C' = x - \alpha(x+n+\delta)\log(x+n+\delta)$; g is the proportion of tariff revenue, i.e., excluding the government transfer; α_k and α_h denote the saving ratio of physical and human capital, respectively. Because of a lack of cross-country data the tariff revenue variable is ignored in the regression. A sample of 81 countries is used in the regression for the period 1960-1985. S_k is measured as the mean proportion of real investment in real GDP. The saving rate of human capital (S_h) is represented by the secondary school enrolment ratio in 1960. The ratio of total imports to GDP is used as a measure of openness. Import share is assumed to be determined by some structural features of the economy. To capture the impact of these factors the share of imports to GDP is regressed on geographical size, distance to foreign markets, and trade distortion measures. The distance variable is calculated by taking the distances from the national capitals of the top 20 exporters. The trade distortion index is represented by tariff rates and black market premium.

The estimated results can be shown in the following equation form:

$$\log realGDP = \underset{(274.32)}{2.0848} - \underset{(4.86)}{0.0136}\log(Y) + \underset{(4.76)}{0.01}\log(Sah) + \underset{(4.85)}{0.0194}\log(Inv) - \underset{(1.90)}{0.15}\pi\log(1+Tar)$$
$$\overline{R}^2 = 0.527$$

Standard error of estimate (SEE): 0.0132 (3.26)
Figures in parentheses are t-values.

These results suggest that tariffs have a negative impact on growth when initial level of income and saving rate are controlled.

The regression results, which included the black market premium variable, can be written as follows:

$$\log realGDP/capita = \underset{(11.27)}{0.08} - \underset{(5.20)}{0.0135}\log(Y) + \underset{(4.90)}{0.0098}\log(Sch) + \underset{(4.36)}{0.017}\log(Inv) - \underset{(3.35)}{0.0891}\pi\log(1+BMP)$$
$$\overline{R}^2 = 0.568$$

Standard error of estimate (SEE): 0.0126 (3.27)
Figures in parentheses are t-values.

These results also support the hypothesis that black market premia and growth are negatively correlated.
Putting both tariff and BMP in the regression the following results were obtained:

$$realGDP/capita = \underset{(11.34)}{0.0828} - \underset{(5.62)}{0.0146}\log(Y) + \underset{(5.06)}{0.0101}\log(Sch) + \underset{(4.21)}{0.0164}\log(Inv) - \underset{(4.50)}{0.1134}\pi\log(1+Tar)$$
$$- \underset{(3.10)}{0.0829}\pi\log(1+BMP)$$
$$\overline{R}^2 = 0.575$$

Standard error of estimate (SEE): 0.0125 (3.28)
Figures in parentheses are t-values.

Since the coefficients of both tariff rate and BMP are statistically significant, the results support the hypotheses that these two variables have a negative impact on economic growth. The results show that on average a country with an import share of 0.2 under a free trade policy, distortionary trade regimes, such as a 25 percent tariff and 50 percent black market premium, have led income per capita growth rate to decline by about 1.4 percent per year during the study period of 1965-1980. Furthermore, to capture the impact of distortionary measures on capital accumulation which will in turn affect the growth rate, the investment rate has been regressed on the two policy variables (measures), and the following results were obtained:

$$DomesticInv/GDP = \underset{(10.94)}{0.2747} + \underset{(0.43)}{0.0053}\log(Y) + \underset{(3.51)}{0.0298}\log(Sch) - \underset{(2.17)}{0.7622}\pi\log(1+Tar) - \underset{(1.71)}{0.2067}\pi\log(1+BMP) \quad (3.29)$$

$$\bar{R}^2 = 0.466$$

Standard error of estimate (SEE): 0.0586
Figures in parentheses are t-values.

These results show that distortionary measures have a negative impact in investment growth. Based on these findings Lee (1993) suggested that distortionary measures affect growth rate both directly and indirectly; directly by decreasing the productivity of capital and indirectly by diminishing capital accumulation. These findings led Lee (1993) to conclude that "although in theory protecting specific sectors with scale economies can lead to higher efficiency and thus to higher growth, the empirical results, using cross-country data, do not support this speculation (p.326)."

Using an innovative measure of alternative trade orientation, Dollar (1992) examines sources of growth in 95 developing economies over the period from 1976 to 1985. According to this paper there are two basic factors, which determine the two distinctive trade policies (inward and outward-orientation). Outward-orientation is characterised by low level of protection, which enhance higher exports as a result of sustainable level of real exchange rate, and minimal real exchange rate variability, while inward-orientation is characterised by a high level of protection and unsustainable real exchange rate and high real exchange rate variability. Misalignment (over- or under-valuation) of exchange rate causes unsustainability in the exchange rate, which in turn has negative impact on growth, assuming other things are constant.

Dollar developed a technique for estimating a cross-country index of real exchange rate distortion using the international comparison of prices prepared by Summers and Heston

(1988).[7] This index measures the extent to which the real exchange rate is distorted away from its free-trade level by the trade regime. The evaluated index shows that the real exchange rate for Latin America, on average, was overvalued by 33 percent relative to Asia during 1976-1985, while Africa was overvalued by 86 percent.

Dollar's study focuses on the prices of tradable goods only, and thus the effect of systematic variations that occurs as a result of the presence of non-tradable is ignored. This approach is implemented by first regressing the relative price level of country *i* (RPL_i) on the level and square of GDP per capita, regional dummies for Latin America and Africa, and periodic dummies. Letting $R\hat{P}L_i$ to be the predicted value obtained from RPL_i regression, the index of distortion is $RPL_i / R\hat{P}L_i$, which is averaged over a period of 1976-1985. The variability index, on the other hand, is computed by taking the coefficient of variation of the annual observation of $RPL_i / R\hat{P}L_i$ for each country over the same study period 1976-1985. A sample of 95 developing countries is included in the study, and the countries are divided into four categories based on trade orientation indices (distortion and variability).

A simple model is estimated in which per capita GDP growth is a function of share of investment to GDP, real exchange rate variability, and the index of real exchange rate distortion. The implicit model underlying the regression is that the investment rate affects the availability of capital, whereas outward orientation accelerates the technological development of the economy. The cross-sectional regression is carried out across the 95 developing countries in the data set. The estimated equation can be written as follows (the benchmark specification includes investment rate as a share of GDP that is averaged over 1976-1985 as a regressor along with distortion and variability indicators):

$$\begin{aligned} &\textit{Per Capita GDP Growth} = 1.65 - \underset{(3.06)}{0.017}\,\textit{Distortion} - \underset{(3.23)}{0.08}\,\textit{Variability} + \underset{(3.93)}{0.14}\,\textit{INV} \\ &R^2 = 0.38 \end{aligned} \tag{3.30}$$

Figures in parentheses are t-values.

[7] The Summers-Heston work compares prices of an identical basket of consumption goods across countries. Letting the US dollars be the benchmark, the data provides estimates of each country's price level (RPL_i) relative to the US dollar: $RPL_i = 100 * eP_i/P_{US}$, where e is the exchange rate and P_i is the consumption price index for country i.

Since the coefficients of each of the variables in the regression hold the expected signs and are statistically significant, the results can be interpreted, as growth is positively associated with investment rate and negatively correlated with the distortion and variability of real exchange rate. However, Rodriguez and Rodrik (1999) find that the results for the trade distortion variables are not very robust to alternative specification of the growth equation. For instance, when dummy variables were included for Latin America, Asia and Sub-Saharan Africa, the trade distortion indexes became insignificant, and also following the inclusion of initial levels of income and education (human capital), the explanatory power of distortion measures reduced. Furthermore, Rodriguez and Rodrik (1999) use the revised version of Summers-Heston data set, for the same sample countries and period covered by Dollar, to find that the trade distortion index is not significant and also holds the wrong sign even without the inclusion of the regional dummy variables. Nevertheless, the exchange rate variability index maintains a negative sign and is continuously significant at conventional levels. As Rodriguez and Rodrik (1999) noted, the results show only that exchange rate variability is negatively associated with growth, but fail to demonstrate that outward-orientation is significantly related to economic growth in developing countries.

Dollar's study has also been criticised for not considering the standard regressors of GDP, such as human capital (education) in addition to regional dummies. The variability index or variable is used in this study in order to avoid the anomalies that arise if the distortion measures are only used. As Dollar noted "among the major anomalies Korea and Taiwan have the highest distortion measures of the Asian developing economies or that Peru is found to have a low level of distortions (p. 530)." Furthermore, developed countries are expected to be less distorted, but the ranking suggests that a number of them are highly distorted. Among the least distorted countries Sri Lanka, Bangladesh, Mexico, Pakistan and Nepal are in the top ten. Bangladesh is rated as less distorted than United Sates. As Dollar noted, combining real exchange rate variability with distortion measures seem to reduce the number of anomalies. As Rodriguez and Rodrik (1999) argue, there is also a serious doubt that variability measures trade orientation. In general, it measures economic instability, which could arise as a result of price disturbance.

In an influential paper, Sachs and Warner (1995) attempt to resolve the ambiguity and the problems of measuring trade orientations by constructing a binary index of openness that combines various issues of trade policy. According to this study a country's trade policy is considered to be closed if it satisfies one of the following criteria:

1) Non-tariff barriers (NTBs) covered 40 percent or higher than imports.

2) It had average tariff rate of 40 percent or more.

3) Black market exchange rate that is depreciated by at least 20 percent relative to official premium during 1970s and 1980s.

4) It had a socialist economic system.

5) It had state monopoly of major exports.

In the regression equation the openness index takes a value of 1 if the country is considered to be open according to the above characteristics and zero if the country is considered to be closed over the period of 1970s and 1980s.

Controlling for such variables as the investment rate, ratio of government expenditure in GDP, secondary and primary schooling, and number of revolutions and coups, the estimated growth equation yields the following results:

$$\begin{aligned}G7089 = &\underset{(3.850)}{9.539} - \underset{(-3.765)}{1.269}\,LGDP70 + \underset{(5.403)}{2.450}\,OPEN + \underset{(1.385)}{2.568}\,SEC70 + \underset{(0.335)}{0.308}\,PRI70 - \underset{(-1.906)}{6.107}\,GVXDXE \\ &- \underset{(-0.119)}{0.090}\,REVCOUP - \underset{(-1.251)}{1.699}\,ASSASSP - \underset{(-2.656)}{1.02}\,PPI70DEV + \underset{(1.708)}{5.662}\,INV7089 \\ &\bar{R}^2 = 0.538 \qquad N = 79\end{aligned} \tag{3.31}$$

Figures in parentheses are t-values.

In the estimated equation above, the coefficient of openness (*OPEN*) is positive and statistically significant indicating that, on average, open economies grow by 2.45 percent points more than the closed economies. Other factors included in the regression, such as initial level of education and ratio of investment to GDP, are less significant than openness indicator.[8] In re-examining the Sachs-Warner findings, Rodriguez and Rodrik (1999) include the above indicators (which are used as criteria to determine whether a country is open or closed) separately in the regression. They find that only two of the variables (black market premium that is depreciated by at least 20% and the existence of state monopoly of exports) are statistically significant. The remaining indicators, even the measure of tariff levels or coverage of non-tariff trade barriers, are not significant. Furthermore, they pointed out that the state monopoly of the major exports variable only includes 29 sub-Sahara African (SSA) countries who are pursuing structural adjustment progress during the late 80s and early 90s, and, thus, is similar to using a regional dummy for SSA. Considering the significant impact of black market premium variable, Rodriguez and Rodrik argue that it is likely to be a measure of policy failure due other factors (such as, foreign exchange rationing corruption) besides trade policy. Rodriguez and Rodrik question the validity of Sachs-Warner openness measure as it fails to show a significant impact on the volume or growth trade unlike trade taxation and black market premium. They argue that if the openness measure constructed by Sachs and Warner (1995) " has no statistically perceptible effect on trade, it is not clear why it should be treated as a measure of trade policy" (Rodriguez and Rodrik, 1999).

Edwards (1992) used cross-country data to examine the trade orientation, distortion and growth. The study focuses on the impact of trade policy on the speed at which technological improvements take place in developing countries. Two sources of technological improvement are assumed in this study (model): (1) domestic source (innovation), which is determined by the gap between the stocks of world and domestic knowledge; and (2) foreign source (imitation), which is determined by the degree of openness. The rate of knowledge accumulation or technological know-how (progress) can then be written as follows:

$$\frac{\dot{A}}{A} = \left\{ \alpha + \delta \left(\frac{W - A}{A} \right) \right\} + \beta\omega \ , \tag{3.32}$$

where α and δ are exogenously given parameters; W is stock of world's knowledge, ω is the rate at which the world stock of knowledge grows $(i.e., W_t = W_0 e^{\omega t})$; β is the parameter between 0 and 1 that measures the country's ability to absorb foreign technology. Thus, trade distortion measures will affect the value of β negatively. In other words, β is a function of trade distortion measures. $\beta = \beta(\tau)$, where τ is an index of trade intervention with $\beta < 0$

[8] This finding is consistent with other studies such as Bhalla (1994), Delong and Summers (1991), Dollar (1992), and Levin and Renelt (1992).

indicating they are negatively related. $\left\{\alpha + \delta\left(\frac{W-A}{A}\right)\right\}$ is assumed to capture the domestic source of technology. α is the basic rate of innovation; while $\delta\left(\frac{W-A}{A}\right)$ is a catch up term, which states that the higher the gap the faster the technological improvement will be; and finally, $\beta\omega$ measures the proportion of the world stock of knowledge that is absorbed by the developing country.

The empirical investigation is intended to analyse the relationship between trade and growth after controlling for the impact of other economic factors. The model assumes that there is a linear relationship between growth and its determinants:

$$y_i = \alpha_0 + \alpha_1 INVGDP_i + \alpha_2 GAP_i + \alpha_3 \tau_i + \varepsilon_i, \qquad (3.33)$$

where y_i is the average rate of growth of real GDP per capita in country i; $INVGDP_i$ denotes the proportion of country i's investment to GDP; GAP_i is a measure of the gap between the world's and country i's stock of knowledge, $\frac{W-A}{A}$; τ_i is an index of trade intervention in country i; and ε_i is an error term.

The cross section empirical analysis includes 30 developing countries for a period of 1970-1982. There are two basic proxies used to represent the knowledge gap: (1) initial level of real GDP per capita, which is denoted by *RGDP70* (negative coefficient is expected since the hypothesis assumes countries with low initial GDP/capita tend to grow faster); (2) the number of engineers engaged in R&D per one thousand inhabitants, denoted by RD (the coefficient of R&D is also expected to be negative). The idea here is that countries with lower value of R&D will have larger knowledge gap and will tend to grow faster assuming other things are given. A set of broad indices of openness constructed by Leamer (1988) is used as indicator of openness and intervention. These indices measure the overall restrictiveness of trade policy. There are two basic trade policy indicators constructed by Leamer: (1) Openness. This indicator measures the way in which trade policy (both tariff and NTBs) restricts imports; (2) Trade intervention. This indicator is assumed to capture the extent to which commercial policy distorts trade, either positively or negatively.

There are six openness and intervention indices used in this analysis: *INTERV1* - overall intervention index obtained when unscaled (homoskedastic) model is used to predict (estimate) trade flows; *INTERV2* - overall intervention index obtained when a scaled (heteroskedastic) model is used to estimate trade flows; *OPEN1* - overall openness obtained from the unscaled trade model; *OPEN2* - overall openness index computed from residuals of the scaled trade model; *OPENM1* - openness index for the manufacturing sector obtained from homoskedastic trade model; and *OPENM2* - openness index for the manufacturing sector obtained from hetroskedastic trade model. The coefficients of intervention are expected to be negative, while openness indicators are expected to have positive coefficients.

The estimated coefficients of intervention variables *INTERV1* and *INTER2* are expected to be negative, while *OPEN1* and *OPEN2* are expected to be positive.

The estimated equation which included the first openness measure (*OPEN1*) in the OLS regression is as follows:

$$GDP = \underset{(-0.128)}{-0.141} + \underset{(5.614)}{0.282}\,INVGDP - \underset{(-6.066)}{0.120}\,RGDP70 + \underset{(3.785)}{2.004}\,OPEN1$$
$$\bar{R}^2 = 0.760 \qquad (3.34)$$
$$N = 30$$

Figures in parentheses are t-values.

The coefficients of all variables included in this regression have the expected signs and they are statistically significant at a conventional level. The $\bar{R}^2$ value also indicates that the explanatory power of the estimated regression model is high enough to explain the cross-country variability in average growth.

When the alternative measure of knowledge gap (*RD*) is used in the regression the following results is obtained:

$$GDP = \underset{(0.264)}{0.376} + \underset{(2.955)}{0.187}\,INVGDP - \underset{(-2.547)}{4.31}\,RD + \underset{(3.975)}{2.305}\,OPEN1$$
$$\bar{R}^2 = 0.501 \qquad (3.35)$$
$$N = 26$$

Figures in parentheses are t-values

As in the case of *RGDP70*, *RD* also has a negative coefficient which is statistically significant supporting the hypotheses that countries with lower level of initial income per capita and larger knowledge gap tend to catch up faster, and most importantly, the openness indices provided strong support that countries which are open tend to grow faster.

The regression analysis on the impact of trade interventions can be summarised using the following equations:

$$GDP = \underset{(-1.484)}{-1.572} + \underset{(7.34)}{0.36}\, INVGDP - \underset{(-5.719)}{0.126}\, RGDP70 - \underset{(-2.518)}{1.191}\, INTERV1$$
$$\bar{R}^2 = 0.70 \qquad (3.36)$$
$$N = 30$$

Figures in parentheses are t-values

and when the alternative measure of trade intervention is included the following result is obtained:

$$GDP = \underset{(-1.606)}{-2.117} + \underset{(4.190)}{0.364}\, INVGDP - \underset{(-2.925)}{6.003}\, RD - \underset{(-1.854)}{6.008}\, INTERV2$$
$$\bar{R}^2 = 0.395 \qquad (3.37)$$
$$N = 26$$

Figures in parentheses are t-values

In general, the regression results provide strong support for the hypotheses that countries with less distortive trade policy tend to grow faster.

To examine whether the impact of other growth determinants is captured by openness and intervention indices, Edwards (1992) included human capital, political instability and government size in the analysis. The proportion of secondary school enrolment to total population (ED) and its growth (GED) are used as proxy for human capital. He obtained the following result:

$$y = \underset{(-0.108)}{-0.118} + \underset{(4.082)}{0.247}\, INVGDP - \underset{(-6.019)}{0.129}\, RGDP70 + \underset{(3.750)}{1.984}\, OPEN1 + \underset{(1.37)}{0.02}\, ED$$
$$\bar{R}^2 = 0.76 \qquad , \qquad (3.38)$$
$$N = 30$$

Figures in parentheses are t-values.

Where y is the rate of growth of GDP per capita.

When the alternative index for human capital (*GED*) is included, the following regression equation is obtained:

$$y = \underset{(-1.521)}{-1.838} + \underset{(3.971)}{0.258}\,INVGDP - \underset{(-6.031)}{0.137}\,RGDP70 + \underset{(2.128}{4.068}\,OPEN2 + \underset{(2.165)}{0.064}\,GED$$

$$\overline{R}^2 = 0.694 \qquad (3.39)$$

$$N = 28$$

Figures in parentheses are t-values.

To examine the impact of political instability an index that measures the perceived probability of government change was included in the regression and the following result is obtained:

$$y = \underset{(1.814)}{2.612} + \underset{(2.165)}{0.183}\,INVGDP - \underset{(-3.124)}{0.119}\,RGDP70 + \underset{(3.516)}{2.39}\,OPEN1 - \underset{(-1.518)}{1.803}\,POL$$

$$\overline{R}^2 = 0.691 \qquad (3.40)$$

$$N = 30$$

Figures in parentheses are t-values.

Finally, adding government size, where the proportion of government to GDP is used as a proxy for the size of government, the following result is obtained:

$$y = \underset{(-0.686)}{-0.761} + \underset{(2.711)}{0.383}\,INVGDP - \underset{(-6.347)}{0.127}\,RGDP70 - \underset{(-2.680)}{1.165}\,INTERV1 - \underset{(-2.193)}{0.076}\,GOVEX$$

$$\overline{R}^2 0.761 \qquad (3.41)$$

$$N = 29$$

Figures in parentheses are t-values.

The result suggests that government expenditure has negative impact on growth. More importantly, the inclusion of different growth determinant variables did not alter the significance of the trade policy variables used in the regression. Based on these findings, Edwards concludes that the empirical findings can be considered as persuasive "evidence on the existence of a strong and robust relationship between trade orientation and economic performance" (p. 55).

In his further study Edwards (1998) used comparative data set for 93 developing and developed countries to examine the relationship between openness and growth. In addition to initial per capita income and a measure of schooling, nine alternative trade policy indicators were included in the analysis of openness and growth. Three of these indices measure openness, while the remaining six measure the extent of policy-induced distortions. The nine openness indicators are: 1) Sachs and Warner openness index (OPEN): this index has a value of 1 if the country is considered to be open and zero otherwise; 2) World Development Report outward orientation index (WDR): countries are classified into four groups depending on the degree on their openness. 3) Leamer. This measure is computed by Leamer (1988) using HOS model on the basis of the average residuals from regression of trade flows. 4) BLACK - measures the extent of the distortion caused by black market premium in foreign exchange. 5) TARIFF - an index for average import tariff rates. 6) Non Tariff Barriers (QR) - the average coverage of nontariff barriers. 7) HERITAGE (Heritage Foundation Index of Distortions in International Trade) - measures the extent of policy-induced distortions. 8) Collected Trade Taxes Ratio (CTR) - The ratio of total revenues on taxes on imports and exports to total trade. The ratio of total revenues on trade taxes (export + import). 9) Wolf - Hoger Wolf's regression based on import index of import distortions for 1985.

The cross-section regression equation includes three basic determinants of TFP growth: 1) the log of initial GDP per capita (GDP 65). 2) Initial level of human capital. 3) Openness indicators. The reported results are weighted least squares (WLS) regressions of TFP growth on the openness indicators for 1980-1990. Six of the nine openness indicators are significant and all but one have the expected sign.

The weighted and instrumental weighted least squares were used to estimate 18 TFP growth equations and the results show that initial GDP per capita has negative impact on TFP growth. In all 18 regression equations the estimated coefficient of initial GDP per capita is negative, and 16 of them are statistically significant, Secondly, in all 18 regression equations the coefficient of initial human capital is positive, as expected, and statistically significant at conventional level implying that human capital is important for LDCs to absorb foreign technology. Finally, all 18 estimated equations, except one, have positive coefficient of openness indicators (variables), of which 13 of them are statistically significant.

In a further analysis Edwards builds an additional indicator (called the first principal component) that combines five of the nine (1,4,5,6, & 9) openness indicators as a grand composite index to avoid the possible loss of some of information by including only one indicator in each regression equation. This is because of the fact that each indicator measure or capture different aspect of trade policy. When the computed trade intervention index which is called the "first principal component" (FAC) is included in the regression the following results were obtained:

$$TFPGROWTH = \underset{(2.0)}{0.08} - \underset{(-2.3)}{0.013}\,GDP65 + \underset{(2.7)}{0.005}\,HUMAN65 - \underset{(-2.8)}{0.07}\,FAC$$

$$R^2 = 0.32 \qquad (3.42)$$

$$N = 60$$

Figures in parentheses are t-values.

The estimated coefficient of the openness (composite) index is negative, as expected, and statistically significant implying that more open countries tend to grow faster than those, which undertake protectionist measures. These findings led Edwards to suggest that " in my view these results are quite remarkable, suggesting with tremendous consistency that there is a significantly positive relationship between openness and productivity growth." However, criticising his method of using per capita GDP as a weighting variable for presumed heteroschedasticity problem, Rodriguez and Rodrik (1999) find that only four of the openness measures used in Edwards (1998) study to be significant when the log of GDP per capita is used as a weighting variable. These four variables are the World Bank's subjective classification of trade regimes, the black market premium, the subjective index of trade distortions calculated by the Heritage Foundation, and the ratio of trade taxes to total trade. Furthermore, using different sets of data for ratio of trade taxes, they find this variable with a positive coefficient although not significant. They also point out that the Heritage Foundation index was calculated for trade restrictions existing in 1996, whereas the regression in Edwards (1998) study covers the 1980s. After calculating a similar index based on the 1980s data, it becomes insignificant. Objecting to the use of this and the World Bank's indicator as being a subjective measure, they note that "apparently highly contaminated by judgement biases or lack robustness to use of more credible information from alternative data source" (Rodriguez and Rodrik, 1999; pp 28).

Salvatore and Hatcher (1991) also employed the trade orientation classification constructed by World Bank (1987), and they obtained partial support for the hypothesis that international trade benefits developing countries and that an outward orientation leads to a more efficient use of resources and growth. The study includes 26 countries for a period of 1963-1985. Because of the 1970s oil price shock and other macroeconomic stagnation, the study period is divided into two sub-periods, 1963-1973 and 1973-1985.[9]

Drawing a variety of openness measures, originally employed by other studies, Harrison (1996) examines the relationship between openness and growth. The general form of the estimated equation is:

$$d\log Y_{it} = dA/A_{it} + \alpha_1 d\log K_{it} + \alpha_2 d\log prim_{it} + \alpha_3 d\log Sec_{it} + \alpha_4 d\log Lab_{it} + \alpha_5 d\log Land_{it} \\ + \alpha_6 Openness + f_i + e_{it} \tag{3.43}$$

where dA/A is technological change, $d\log K$ is capital stock, $d\log prim$ is primary education, $d\log Sec$ is secondary education, $d\log Lab$ is labour force, $d\log Land$ is arable land and $Openness$ is trade policy variable.

The following seven indices for trade and exchange rate policies were used in this analysis: (1) Annual index of trade liberalisation for 1960-1984 (TRI), which is derived using country-specific information on exchange rate and commercial policies (originally used by Dapagergiou et al, 1991). (2) Index of trade liberalisation for 1978-1988 (TRII). Computed using country sources on tariff and NBs (originally constructed by Thomas et al., 1991). (3) Black market premium (BLACK), calculated as the deviation of the black market rate from

[9] This dichotomy is supported by trade strategy changes of some of the countries in the sample. Colombia and Ivory Coast switched from moderately outward strategy to a moderately inward strategy, Nigeria switched from moderately inward to

the official exchange rate. (4) The share of trade in GDP (TR share), which is defined as the proportion of the sum of exports and imports to GDP. (5) Movements toward international prices (MTIP), which is derived from the relative price of a country's tradable goods that is computed using current and constant national accounts price indexes. Using the relative price of consumption goods for 1980 as a benchmark, it is transformed to measure the movement toward unity. (6) (DOLLAR). This variable is an index of price distortion used in Dollar (1991). High values for the Dollar index indicate high relative prices for consumption goods, implying a more distortionary trade policy. (7) The indirect bias against agriculture from industrial sector protection and overvaluation of the exchange rate (INDIRECT). A value of INDIRECT implies lower industrial protection and overvaluation of the exchange rate.

The cross-country regression equation, which uses 27-year averages, show that measures of openness are generally not significant in having any impact on growth. Of the 7 trade policy variables, it is only black market premium (BLACK), which has the expected sign (negative) and statistically significant coefficient. Among other economic factors included in the regression, capital stock is the only variable, which has a statistically significant positive coefficient, i.e., a one percentage point increase in capital stock increases GDP growth between 4 and 6 percentage points. The initial level of GDP in 1960 has also been found to be insignificant, which is interpreted that the sample developing countries did not exhibit convergence in GDP growth rates. The estimated coefficient for the remaining two variables included in the regression, arable land and human capital, are also not significant statistically. Harrison argues that using period averages hinder some relevant information, as there has been so many policy changes took place in developing countries over the 27 years of the study period. A further investigation, which employs panel data set, was computed, and the results provide a strong support for the hypothesis that more open economies tend to grow faster than the closed economies.

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strongly inward, Tunisia from moderately inward to moderately outward, while Chile, Turkey, and Uruguay from strongly inward to moderately outward trade orientation.

Gundlach (1997) examines the impact of openness on economic growth using the binary openness measures computed by Montiel (1994), which classifies countries as open or closed based on the degree of capital mobility.[10] The study includes 22 developing countries of which 13 are considered to be open (Benin, Cameroon, Chile, Colombia, Costa Rica, Ecuador, Malaysia, Mauritius, Mexico, Paraguay, Peru, Sierra Leone, and Uruguay) and nine are considered to be closed (Honduras, Kenya, Malawi, Nepal, Niger, Nigeria, the Philippines, Venezuela, and Zimbabwe. the study considers the regression equation in which conditional growth rate is a dependent variable. The estimated results can be summarised using the following equation:

$$\begin{aligned} &\textit{Conditional growth rate} = \underset{(0.73)}{2.53} + \underset{(1.09)}{3.62}\, OPEN - \underset{(0.09)}{0.31} \ln(Y/L) - \underset{(0.31)}{0.41}\, SLOPEN \\ &\bar{R}^2 = 0.76 \\ &N = 22 \\ &SSE = 0.22 \end{aligned} \qquad (3.44)$$

Figures in parentheses are t-values.

3.5.3 Simultaneous equation models

Esfahani (1991) developed a simultaneous equations model by considering the endogeneity of export and import. The model comprises of 3 independent variables, namely, per capita GDP growth, the product of ratio of export in GDP and growth rate of per capita exports, and the product of the ratio of import to GDP and per capita growth of imports. The regression equations in this model are derived from production functions. Thus, it enables the author to give direct interpretation of the results. For example, according to the model, the export ratio variable implies the assumption that it has positive externality on productivity to the non-export sector or that the country is foreign currency constrained. In this, regression, the coefficient of export becomes insignificant whenever imports are included in the regression, while in all regressions an import variable is positive and statistically significant.

[10] Montiel (1994) employs the approach, which originally developed by Feldstein and Horioka (1980). Their approach is that regressing investment share on saving rate to determine the degree of capital mobility. The result, which they called it 'saving retention coefficient', estimates the proportion of domestic saving that is allocated to domestic investment. A value of 1 indicates that the economy is closed, as it implies the whole of the domestic saving is retained for domestic investment. A value of 0, on the other hand, indicates the economy is completely open as it implies domestic saving would have been exported as foreign investment.

Esfahani (1991) interprets these results by noting that while the efficiency-enhancing role of exports is weak, exports do play an important role in easing the import constraints of semi-industrialised countries.

Sprout and Weaver (1993) developed a model, which endogenises export growth in a structural simultaneous equation. Unlike many other studies that employ OLS, Sprout and Weaver use two-stage least squares (2SLS) estimates to investigate the relationship between exports and economic growth. A set of three simultaneous equations is formulated: the first equation is intended to measure the impact of export on economic growth. The second and third equations include indices for trade structures as determinants of capital formation and export growth, respectively.

The model equations are specified as follows:

$$DGNP = a_1 + a_2 GDI + a_3 DLABOUR + a_4 DX \quad (3.45)$$

$$GDI = b_1 + b_2 GDPPC + b_3 DGNPPC + b_4 XSHARE + b_5 KI \quad (3.46)$$

$$DX = c_1 + c_2 DGNP + c_3 PRICE + c_4 TPGROWTH + c_5 TPCON + c_6 TSCOMP \quad (3.47)$$

where *DGNP* is growth of real GNP, *GDI* is ratio of gross domestic investment to GDP, *DLABOUR* is growth of labour force, *DX* is growth of real exports (DX_I), or growth of ratio of export to GDP, *GDPPC* is real GDP per capita, *DGNPPC* is growth of real GNP per capita, *XSHARE* is share of export to GDP, *KI* is ratio of capital inflow to GDP (net imports of goods and services), *PRICE* is price competitiveness (inflation and exchange rate changes in the LDC relative to its five leading trading partners), *TPGROWTH* is trade partner's growth (weighted average of real GNP growth of the LDC's five leading partners), *TPCON* is trade partner concentration (proportion of total exports received by the LDC's three leading partners), *TSCOMP* is trade structure composite (average of the value of primary exports as a proportion of total exports [*PRIMX*] and the value of the two leading export commodities as a percentage of total exports [*CCNO*]. income (*DGNPPC*), the size of the export sector (*XSHARE*), and foreign capital inflows (*KI*). Equation 3.47 states that there are five elements which determine export growth: 1) Growth rate of GNP (*DGNP*); 2) The price competitiveness of the LDC relative to its trading partners (PRICE); 3) Economic growth of the LDC's trading partners (*TPGROWTH*); 4) The extent of the LDC's exports restriction to a few trading partners (*TPCON*); 5) Composition and concentration of the LDC's exports (*TSCOMP*). applies more to small non-primary good exporters and large LDCs. These results shouldn't be surprising since the level of development of countries that are exporting non-primary goods is higher than those who are exporting primary commodities.

The estimated results of the above simultaneous equations (3.45 - 3.47) show that there is a positive and statistically significant relationship between the share of exports to GDP and *GDI* (ratio of domestic investment to GDP) in all three subgroup economies. The highest effect of XSHARE on GDI is, however, observed to be on largest LDCs. The estimated results, which take, exports growth as dependent variable, show that the effect of economic growth on export growth is greatest among the largest LDCs. These findings led Sprout and Weaver to suggest that there is a bi-directional causality between exports and economic growth in large LDCs. They also noted that the trade structure has indirect impact on economic growth through its effect on investment and export growth.

In equation 3.45, the growth of labour and capital are proxied by *DLABOUR* and *GDI*, respectively; and they both are expected to have positive correlation with GNP growth along with export growth. Equation 3.46, on the other hand, shows that investment (*GDI*) is determined by the level of real per capita income (*GDPPC*), the growth of real per capita effect of *XSHARE* on GDI is, however, observed to be on largest LDCs. The estimated results, which take exports growth as dependent variable, show that the effect of economic growth on export growth is greatest among the largest LDCs. These findings led Sprout and Weaver to suggest that there is bi-directional causality between exports and economic growth. They also noted that trade structures have indirect impact on economic growth through their effect on investment and export growth.

The cross-country regression test included 72 developing countries for a period of 15 years (i.e., 1970-1984). Sample countries were divided into 3 groups (large exporters, small primary good exporters, and small non-primary good exporters) based on their level of income, geographic region, export composition and size. The estimated results suggest that there is a positive relationship between exports and economic growth for non-primary commodities exporters. A 1 percent increase in real exports (DX_1) and growth of export share (DX_2) are associated respectively with 0.31 and 0.63 percentage increases in economic growth. Comparative figures for small primary good exporters and large exporters are 0.10 and 0.13, and 0.18 and 0.54, respectively.

Frankel, Romer and Cysrus (1996) use instrumental variables as a means of addressing the perceived simultaniety problem in the openness-growth relationship. They based their regression equation on Mankiw, Romer and Weil (1992), where the dependent variable is per capita GDP. Mankiw et al derived this specification from the steady state predictions of a Solow growth model with a Cobb-Douglass producion function and exogenous technological changes and population growth. Franke et al extended the Mankiw et al empirical analysis by including the ratio of trade (export + import) to GDP in the regression. The instrumental variables regression results show that trade has a significant impact on GDP per capita. Easterly, Loayza and Montiel (1997) have employed panel data set to tackle the endogeneity problem. They find that their openness measure (ratio of trade to GDP) is positive and significant.

Using an instrumental variable technique, Levine and Renelt (1992) examine the robustness of earlier empirical findings on the growth analysis. Their study investigates the impact of slight alterations on the explanatory variables on the empirical findings of various earlier studies. In doing so the results provide the consistency or changes of the coefficients of policy variables due to slight change in the information set. Two basic themes could be drawn from these study: 1) policy measures are significantly correlated with long-run per capita growth; 2) a slight alteration in the policy indicators make an impact on the previous findings, implying that most of the findings are fragile. Their empirical results show that there is a positive and robust correlation between growth and ratio of investment to GDP, and between the ratio of trade to output and investment share. The regression equation assumes that independent variables are entered independently and linearly, thus the regression equation takes the form:

$$Y = \beta_i I + \beta_m M + \beta_z Z + \varepsilon \quad , \tag{3.48}$$

where Y is either growth of per capita GDP or the share of investment in GDP, I is the set of variables always included in the regression, M represents the variables chosen to be tested, and Z is a subset of variables, which have been used as explanatory variables of growth. They use extreme-bounds analysis (EBA) to examine the robustness of coefficient estimates to slight alterations in the information set.

The regression results with I variables for the period 1960-1989 are:

$$GYP = \underset{(0.85)}{-0.83} - \underset{(0.14)}{0.35}\,RGDP60 - \underset{(0.22)}{0.38}\,GPO + \underset{(1.29)}{3.17}\,SEC + \underset{(2.68)}{17.5}\,INV$$

$$R^2 = 0.46 \qquad N = 101 \tag{3.49}$$

Figures in parentheses are t-values

These results show that all but GPO have the predicted sign and are significant at 5 percent level, which implies that there is a robust negative relation between GYP and initial income (GDP), positive correlation between investment and GYP; and between schooling and GYP. However, the estimated equation, which uses investment share as a dependent variable, gives fragile results:

$$INV = \underset{(0.003)}{0.006}\,RGDP60 - \underset{(0.005)}{0.013}\,GPO + \underset{(0.023)}{0.08}\,SEC \tag{3.50}$$

$$R^2\, 0.06$$

Figures in parentheses are t-values

Surprisingly, the coefficient of initial income is positive although it is not statistically significant. There are two major themes that could be drawn from this analysis. Many indicators of policy, taken individually or in groups, are correlated with growth, but the relationship between growth and any particular indicator or group of indicators is typically fragile.

3.5.4 The causality issue

The econometric estimation of causality between economic variables was pioneered by Granger (1969). A variable X_t is said to Granger cause Y_t if Y_t can be better explained (predicted) by using X_t's previous information than without using the past history of X_t. The main feature of the notion behind Granger causality is that for X_t to Granger cause Y_t the information set on X_t should contain unique information about Y_t that is not available elsewhere. However, it should be emphasised that the issue of causality need not be associated with the arbitrarily selected set of variables, but only for which the researcher believes there is possible causation.

When one considers a bivariate model, causality can run in three different directions: first, X_t causes Y_t; second, Y_t causes X_t; and third, X_t causes Y_t and also Y_t causes X_t in a feedback or bidirectional causality. If neither X_t causes Y_t nor Y_t causes X_t, the two variables are said to be statistically independent. Most econometric studies use Granger test to examine the relation between export and GDP.[11] For a bivariate model a typical Granger test is constructed in the following way:

$$Y_t = a_0 + \sum_{i=1}^{k} a_i Y_{t-i} + \sum_{i=1}^{k} b_i X_{t-i} + \varepsilon_t \qquad (3.51)$$

$$X_t = c_0 + \sum_{i=1}^{k} c_i X_{t-i} + \sum_{t-i}^{k} d_i Y_{t-i} + \mu_t \qquad (3.52)$$

where X_t and Y_t represent stationary time series and ε_t and μ_t are uncorrelated error terms. For X_t to Granger cause Y_t or vice versa requires that at least some b_i and d_i in 3.51 and 3.52 are significantly different from zero. Bidirectional causality, on the other hand, requires that $b_i \neq 0$ and $d_i \neq 0$ for at least some i.

There are two different groups of causality test studies: one group is employing Granger-Sims technique, while the other group employs cointegration and an error correction model approach. As a result of different techniques and data sets used, there are spectrum of results with divergent conclusions.

In an attempt to investigate the direction of causality, Jung and Marshal (1985) did the Granger causality test using time series data set for 37 countries. Their study relies on temporary predictability as an indication of causation in testing the hypotheses of export promotion. Their analysis is based on the Granger's (1969) arguments that the ability of a variable Y is an operationally meaningful interpretation of the statement that X causes Y. In other words, export causes growth provided that all the apt information set for both export and growth is used. They argue that their time series analysis is a more accurate methodology than the cross-sectional analysis normally used in these studies, since the stability of coefficients may not hold across countries. Their empirical results show that out of 37 countries considered in only four they observed evidence in support of export expansion hypotheses.

Out of 37 sample countries only 4 countries adhere to the causality of export to economic growth. Even the most prominent export-oriented countries (which experienced "miraculous" growth rates (such as, Korea and Taiwan) failed to support the hypothesis of causality of export to growth. These findings led the authors to conclude that the evidence cast doubt on the efficacy of export promotion policies in generating (fostering) economic growth. However, there are some doubts to the validity of this test: first, the theoretical background might not be explained by a Granger causal relationship.

Along the same line Dodaro (1993) employs causality tests and finds that there is weak support for export-led growth hypotheses. There is, however, weak but strong support for the alternative hypothesis, which states GDP growth, promotes export expansion (growth). According to Dodaro (1993) the impact of export on growth depends on the stages of development, that is, in the earlier stages economic growth promotes export growth while in the later stages of development export growth is more likely to promote overall economic

[11] The Sims (1972) test is also used as alternative to Granger test, although the latter is by far the most common.

growth. Dodaro employs a time series analysis using ordinary least squares (OLS) for a period of 1967 - 86. The basic estimated equation can be written as follows:

$$GY = a_0 + a_1 Gx_{t-1}, \qquad (3.54)$$

where t is time, Y is real GDP, X is real exports of goods and nonfactor services, $GY_t = Y_t - Y_{t-1} / Y_{t-1}$; and $Gx_t = X_t - X_{t-1} / X_{t-1}$. Using 1978 nominal GNP per capita 87 developing countries are included in the study. Out of 15 of the poorest countries only three of them show a positive correlation between exports and GDP growth. Although the coefficients for four of the newly industrial countries (NICs) - Hong Kong, Korea, Singapore, and Greece - are positive and significant at a conventional level, for the remaining NICs - Brazil, Mexico, and Portugal - the coefficients are not significant.

To examine the causality effect between export and economic growth, Dodaro adopted the methodology employed by Jung and Marshall (1988) in which the dependent variable (Gy_t and Gx_t) is regressed against two-year lagged values of itself and the other variable. The causality test shows that in only 53 countries (out of 87) exports seem to promote economic growth. While 58 cases support the contention that GDP growth promotes export expansion. Dodaro interpreted these findings as a very weak support for the contention that export growth promotes GDP growth, and he also noted that although the causality effect of GDP on export is weak it is somewhat stronger than the former.

Hsiao (1987) considered a group of newly industrialised Asian countries (Hong Kong, Korea, Taiwan and Singapore) in his causality study that covers 1960-1987. He compares his results obtained using both the Granger and Sims' procedure. The results suggest that GDP growth causes exports in Hong Kong on both Granger and Sims test; no causality in other countries on Granger tests and bidirectional causality on Sims test. Ahmad and Kwan (1991) used Granger procedure with Akakie Information Criteria for selection of lag length. 47 African countries were included in this study for the period 1981-1987. The results show that no causality for the full sample; for the high-income group growth of real GDP causes exports; whereas for group of low-income countries growth of real GDP causes a rise in the share of manufactures in total exports.

Dutt and Ghosh (1994) used various cointegration test techniques between real GDP and real exports for 26 developing countries covering the period 1953-1991. The results show that exports and GDP are correlated in 20 out of 26 countries. Along a similar line, van den Berg and Schmidt (1994) applied various cointegration tests for 17 Latin American countries covering 1960-1987, and found that exports and GDP are conitegrated.

The results for African countries (Ahmad and Kwan, 1991) and for ASEAN countries (Ahmad and Harnmirun, 1992, 1995, 1996; Ahmad et al. 1997) provide no support for the export-led growth hypothesis, as exports appeared to have no causality effect on GDP growth. The surprising result might be that there seems to be no support for exports having caused growth even in the prominent export-oriented economies, such as, Hong Kong, Singapore and Taiwan (Chow, 1987; Hsiao, 1987; Chan et al 1990).

More retracting is the result from cointegration studies that employ time-series data. In most cases, exports and GDP are not even cointegrated, implying that there is no long-run relationship between the two variables (Kugler and Dridi, 1993, Dutt and Ghosh, 1994). Tests of exogeneity of the export variable, and its cointegration with growth of GDP, show that there is weak support for the export-led growth hypothesis in China during 1952-1985 (Kwan and Kwok, 1995) and in Taiwan during 1953-1985 (Kwan et al, 1996).

The statistical support for the causality of GDP to export growth appears to be relatively more robust under a variety of model specifications used (Chan et al, 1990; Ahmad and Kwan, 1991; Gordon and Sakyi-Bekoe, 1993; Ahmad and Hernhirum, 1996; and Ahmad et al 1997). In some cases, such as China, the time period seems to make a difference in the direction of causality (Kwan and Cotsomitis, 1991). During 1952-1978 there is no causality in either direction while there appears to be bi-directional causality during 1952-1985.

In attempt to rectify the "omitted variable" bias, some studies use a multivariate model that includes other variables in addition to exports and GDP growth. For instance, Reizman et al (1996) computed Granger causality tests that incorporate import growth for 9 Asian countries. The results provide some evidence both of spurious rejection of export-led growth hypothesis as well as spurious detection of it, when it is compared with bivariate model of export and GDP growth. In his study of the South Korean economy Suliman (1994) used a multivariate model and finds that during 1967-1989 exports seems to have caused GDP growth indirectly through the growth of money supply. Reizman et al (1996), on the other hand, included human capital, investment and imports in their multivariate analysis. The results show that, in the case of Japan, the inclusion of human capital strengthens the inference of economic growth leading to export growth, whereas in the case of Korea it weakens it.

After criticising other studies on grounds of the methodology and econometric technique employed, Bahman-Oskooee and Alse (1993) computed a thorough investigation on the issue of causality between exports and output growth. Since the methodology used is different than in the other studies discussed, we shall discuss their work in relatively more detail. The authors criticise other studies for failing to check for cointegration properties of the time series data employed and the use of rate of changes of export and output. They noted that "Granger or Sims tests are only valid if the original time series from which growth rates are generated are not cointegrated (pp 536)". Instead of a simple causality test they apply the method of cointegration and error-correction models. Cointegration tests filter out the long run information, while the error-correction establishes causality between the two variables. The following conintegration equations are tested:

$$X_t = \alpha_0 + \beta_0 Y_t + \mu_t \tag{3.55}$$

$$Y_t = \alpha_1 + \beta_1 X_t + \mu_t \tag{3.56}$$

And the error correction models are formulated as follows:

$$(1-L)X_t = a_0 + b_0\mu_{t-1} + \sum_{i=1}^{M} C_{0i}(1-L)X_{t-i} + \sum_{i=1}^{N} d_{0i}(1-L)Y_{t-i} + \varepsilon_t \tag{3.57}$$

$$(1-L)Y_t = a_1 + b_1 U'_{t-1} + \sum_{i=1}^{M} C_{1i}(1-L)Y_{t-i} + \sum_{i=1}^{N} d_{1i}(1-L)X_{t-i} + \varepsilon'_t \text{ ,} \tag{3.58}$$

where L is the lag operator and the error correction terms μ and μ' are the stationary residuals from cointegration equations 3.57 and 3.58 respectively.

To determine the degree of integration of each variable the authors use an augmented Dickey-Fuller (ADF) test statistic, and thus, for time series Z, the ADF test statistics is obtained by estimating the following equation:

$$(1-L)Z_t = a + bZ_{t-1} + \sum_{i=1}^{k} C_i (1-L)Z_{t-i} + \omega_t \,, \qquad (3.59)$$

where ω is the error term at time t and L is the lag operator. Using the log of export (*log X*) and output (*log Y*) and substituting for Z in equation in 3.59 the estimated results show that there is no stationarity on the level of the two variables. A further test which included the first differences of the two variables reveal that in all cases (9 countries) the calculated ADF statistic is stationary or integrated of degree zero, i.e., $Z \sim I(0)$, which implies that *log X* and *log Y* are integrated of order one, i.e., they are both ~ I(1). To determine the cointegration between *log X* (export) and *log Y* (output) requires the residuals from the cointegration equation to be stationary or integrated of order zero, *I (0)*. The results of testing for the degree of integration of residuals from the cointegration equation show that except for the case of Malaysia for the remaining of eight countries they are significant at the conventional level, implying that the residuals for the these countries are *I (0)*. As the degree of integration of *log X* and *log Y* is greater than the degree of residuals, it indicates that there is long run relation between exports and output in the case of eight countries in sample.

To investigate the causality effect the authors use the error correction equations 3.57 and 3.58. The results reveal that there is in each of nine sample countries the estimated slope coefficient is positive and significant. This implies that an increase in exports stimulates output growth and an increase in domestic output also stimulates exports growth. In other words, the results suggest there is bi-directional causality between exports and output growth for all countries in the study.

These findings were supported by Bahmani-Oskooee et al (1991) who employed the Granger concept of causality combined with Akaike's Final Prediction Error (FPE) criterion and concluded that their empirical findings support the causality of export to economic growth hypothesis. Darrat (1986) and Hsiao (1987), in contrast, obtained results, for most of developing countries in their sample study the hypothesis of export causes growth is rejected.

Chow (1987) studied the direction of causality between manufacturing exports and industrial development of eight newly industrialised countries. The results show that manufacturing exports did cause industrial development, either unidirectional or bi-directionally[12], in seven of the eight countries in the sample. However, the sample used in this study includes only newly industrialised economies, which will thus give biased result as to its applicability to other developing countries. Chow adopted the Sims procedure in order to analyse the possibility of a dual causal relationship between export growth and economic growth, and he found dual causality in the cases of Brazil, Hong Kong, Israel, Korea, Singapore, and Taiwan; a single causality from export to output growth in the case of Mexico; and no causality at all in the case of Argentina.

3.6 Threshold of Economic Development

The concept of 'critical minimum effort' is usually defined in terms of 'minimum development' as in Michaely (1977) and Helleiner (1986). This section focuses on this issue. The empirical findings discussed above refer either to few individual countries or cross-sectional findings. It is thus plausible to raise an important question for their applicability to all developing countries. A number of studies have shown that the correlation between trade and growth is weaker for low-income countries (e.g. Michaely, 1977; Dollar, 1992).

There are several other studies that focus on the relation between export performance and economic growth [for example, Maizels (1968), Kravis (1970); and Michaely (1977)]. Michaely (1977), for example, uses pooled data for 41 developing countries and find that there is a significant positive relationship between proportional per capita income growth and

[12] If X causes changes in Y or Y causes changes in X, the causality is said to be unidirectional. If, on the other hand, X causes Y and Y also causes X to change the causality is called bi-directional.

the proportional increase in the ratio of exports to GNP. The results also show that the relation between per capita income growth and increase in the ratio of exports was very strong for the 23 (out of 41) relatively most developed countries in the sample. However, Michaely could not discern a significant relationship for the rest of low-income, developing countries. These results led Michaely to suggest that growth is affected by export performance only once countries achieve some minimum level of development.

Perhaps, a very important question for policy makers in developing countries is whether the contention of export-led growth is applicable to all developing countries. A prominent critic of this aspect is Helleiner (1986) who argued that developing countries need to have the minimum level of development in order to benefit from export-oriented policy. Drawing two separate data sets for a sample of 24 low-income countries and 25 African nations, Helleiner examines the applicability of export-led growth hypotheses for the poorest countries.[13] The study modifies Feder's (1983) production function model by taking growth of GDP as function of ratios respectively of investment, import, and export to GDP, the rate of growth of labour force, measure of the instability of import volume, and the income terms of trade. The instability measures are the coefficients of variation (standard error divided by the mean of the dependent variable) of log-linear time trends of each country's import volume and purchasing power of exports (income terms of trade) over the study period of 1960 -79. Contrary to other empirical findings, the regression results show that there is no statistically significant correlation between exports share and economic growth.

The results were consistently negative, although they are not statistically significant at conventional level. When the alternative trade policy variable (share of import to GDP) is included in the growth equation, the results indicate that there is no significant correlation between the two variables. In the total sample of low-income countries the results suggest that none of the external instability measures have significant impact on growth. In the case of sub-Saharan Africa, however, the results show that the import instability index and income terms of trade are statistically significant. These findings led Helleiner to suggest that in the

[13] In Helleiner (1986) study low-income countries are defined those with per capita incomes of $630 or less in 1980.

case of African nations, growth stagnation is explained relatively more significantly by their import instability measures than exports share. He noted that the poor performance of these countries "...has more to do with that the desirability of stabilising import volume than with that of increasing the degree of outward orientation (p. 149)."

An earlier study, which employs a simple rank correlation technique, has shown that the association between export share and rates of growth GNP per capita is much stronger in a relatively higher income countries (Michaely, 1977). For countries with a per capita income of $300 or more, the coefficient of rank correlation between the two variables is found to be 0.523 which is significant at 1 percent level. The comparative figure for countries with a 1972 per capita income of $300 or less is -0.04, which is not statistically significant. These findings led Michaely to suggest that " ... growth is affected by export performance only once countries achieve some minimum level of development" (p. 52). Using a simple production function framework, which includes the export variable as one of the factors of production along with labour and capital, Ram (1985) examines the impact of exports on rate of growth of GNP in 73 developing countries for a period of 1960-1977. In this analysis countries were divided into two groups based on their per capita GNP. Countries with per capita GNP in 1977 of exceeding $300 are considered to be middle-income and not exceeding $300 is low-income. Using a dummy variable that takes the value of 1 if the country is low-income country and zero otherwise, the estimated results show that the impact of exports on growth is higher in the middle-income countries than in the low-income countries regardless of the two sub-periods considered (1960-1970 and 1970-1977).

These results are consistent with an earlier finding, which decomposed export factor into primary and manufacturing exports (Kavoussi, 1984). The study includes 73 developing countries of which 37 are considered to be low-income countries with per capita income in 1978 of $360 or less, and the remaining 36 countries are categorised as middle-income countries those with per capita income of exceeding $360. The study employed both simple rank correlation and regression tests. The Spearman rank correlation coefficient between exports and growth for both low and middle-income countries is positive and statistically significant. The estimated correlation is, however, higher for middle-income countries than for low-income countries with respective correlation coefficients 0.543 and 0.411.

Singer and Gray (1988) extended Kavoussi's (1984) analysis in three ways: (1) their analysis covers period when world economic conditions were unfavourable to developing countries (1977-1983); (2) regional analysis is added in examining the correlation between exports and growth, and (3) sample countries were categorised into high and low income groups based on the absolute level of per capita GNP for each sub-period (1967-1973 and 1977-1983). The cut-off point for the first period was per capita GNP of $228 while for the second period it was $484. The Spearman rank correlation test shows that the correlation coefficient between exports and growth for high-income countries 0.672 during 1967-1973 and 0.484 during 1977-1983, and the comparative figures for low-income countries are 0.511 and 0.348, respectively. These results suggest that the correlation between exports and economic performance is weaker in low-income countries than high-income countries.

Singer and Gray classify sample countries into three regional groups: Latin America, Africa and Asia. The Spearman rank correlation coefficient between exports and economic growth are estimated based on the world market demand. The study period is divided into two: above and below average world market demand. 'Above average world demand' countries are those whose exports are growing above 7.9 percent between 1965-1973 and – 3.8 percent between 1973-1977. 'Below average world demand countries' are those with rates of exports growth less than 7.9 percent between 1967-1973 and falling more than -3.9 percent during 1973-1977. The results show that there is strong correlation between exports and economic growth for Latin America between 1967 and 1973 in both demand conditions. In the second period (1973-1977), however, the results suggest that there is no statistically significant correlation between exports and growth. For Africa, the results show that there is weak correlation in the first period both when facing above and below average world demand. In the second period the results show that there is no correlation when demand was above average, but below average group countries experienced weak correlation between exports and growth. In the case of low income Asia, although the sample size is very small (three), the results show that there is correlation between exports and growth in both sub-periods when facing above average world demand. When demand was below average the results show that there was no statistically significant correlation between exports and economic growth.

In his sensitivity analysis, Dollar (1992) estimated the growth equation for the entire sample 95 developing countries, 48 poorer countries (those with per capita income in 1976 of less than \$1200), and 24 poorest countries (those with income of below \$600). The estimated regression equation for 48 poorer countries is the following:

$$\begin{aligned} y &= 1.23 - \underset{(-4.02)}{0.029}\, D_{RER} + \underset{(0.64)}{0.02}\, V_{RER} + \underset{(3.53)}{0.20}\, I \\ R^2 &= 0.38 \end{aligned} , \qquad (3.60)$$

Figures in parentheses are t-values.

where y growth rate of GNP, D_{RER} is real exchange rate distortion, V_{RER} is real exchange rate variability, and I is investment rate. The results show that the real exchange rate variability index happened to have the wrong sign, although it is not statistically significant while the distortion measure is found to be highly significant. The estimated regression equation for the poorest quartile (24 countries) is as follows:

$$\begin{aligned} y &= 1.86 - \underset{(2.60)}{0.027}\, D_{RER} + \underset{(0.86)}{0.04}\, V_{RER} + \underset{(0.96)}{0.08}\, I \\ R^2 &= 0.26 \end{aligned} \qquad (3.61)$$

Figures in parentheses are t-values

The results for the 24 poorest countries show that real exchange rate variability and investment seized to be statistically significant, while the distortion parameter is highly significant as in the case of other groups. These findings led Dollar to suggest that the real exchange rate is the sole determinant of growth variation for poorest countries.

3.7 Conclusions

In this chapter we have reviewed the empirical studies on the relationship between trade orientation and economic growth. Three basic areas are discussed in this chapter: multicountry analysis of protectionist regimes and liberalisation episodes, cross-national regression analysis of the impact of exports on economic growth, and the impact of openness on growth.

Country specific analysis provides valuable information in which different policies have affected the economic performance of different countries. The comparative analyses of some studies have a great impact for policy makers in reviewing their trade policies. Many of the earlier studies of the 1970s and 1980s, have limited implication because of their empirical and conceptual (analytical) shortcomings. A number of these studies failed to examine the mechanism through which exports affect economic growth, and also fail to include other growth determinants in the empirical analysis. Many studies have been criticised for failing to deal with issues related to endogeneity and measurement errors. These limitations have contributed at large for failing to produce convincing results, which have been found to be fragile in subsequent studies (e.g. Levin and Renelt, 1992).

The endogenous growth models have played an important role in the analysis of the impact of trade on growth. In this growth model it is possible to establish the long-run impact of openness on economic performance, which is not possible in the neoclassical model that assumes a long run equilibrium condition for the steady state growth rate, which is independent of domestic policies (e.g. Feder, 1983). Studies, which employed an endogenous growth framework, have emphasised that openness allows developing countries to absorb new technologies that are developed in advanced nations, which will then help them to grow faster.

Developing countries are often given the policy prescription that emphasises reduction of trade barriers is a more effective way of achieving higher sustainable rates of growth than restrictive trade policies. However, particularly since Bhagwati (1978) and Krueger (1978) studies, researchers who advocate such policy also note the need for other monetary, fiscal, as well as political stability for free trade to be effective in the long run. It does seem to us that various studies support the hypothesis of openness or outward-orientation.

The East Asian experience should be analysed cautiously. The absorptive capacity of these countries has not been analysed in any of the studies. In the 1960s and 70s the South Korean and Taiwanese government, for example, allocated substantial investment on the improvement of infrastructure and education system. This gives us an important clue to investigate the factors that determine the absorptive capacity of developing countries. Our empirical analysis will focus on finding some evidence in which the impact of openness on growth will be determined by the country's level of development, which is defined in terms of its infrastructure and human capital.

CHAPTER 4

Openness and Productivity Growth

4.1 Introduction

In the now classic paper, Sebastian Edwards (1998) carries out cross-section empirical analysis to examine the impact of openness on the growth of total factor productivity (TFP). This chapter replicates and extends Edwards' results by using a sample of 93 developed and developing countries. His estimates of total factor productivity growth are the Solow residuals from panel regression of economic growth on the growth of capital and labour. He uses nine alternative openness indicators in an attempt to find some robust results.

A number of empirical studies (see Chapter 2) deal with the issue of the relationship between openness and growth by using a single indicator of openness, which is usually exposed to serious criticisms. Edwards notes that "the difficulties in defining satisfactory summary indexes suggest that researchers should move away from this area, and should instead concentrate on determining whether economic results are robust to alternative indexes" (1998, p386). His study attempts to find robust results by employing different openness indicators regardless of their background. The results, in general, show that there is a strong positive correlation between openness and the growth of total factor productivity. On the other hand, the empirical analysis of Helleiner (1986) shows that the economic performance of low-income African countries is not associated with outward orientation. Michaely (1977) and Ram (1987) also found no significant contribution of openness to the growth of the least developed countries. The prime explanation of such findings relates to absorptive capacity which is determined by the human capital endowment and the quality of infrastructure (see Appendix 1 for description of absorptive capacity). Such analysis has not been done by Edwards. Another weakness in

Edwards' work is that the sample includes all countries irrespective of a country's stage of development (high-, middle- and low-income).

This chapter adopts Edwards' methodology to examine the impact of openness on growth (see Appendix 2 for the general framework of technological spillovers through trade). We begin our analysis by replicating Edwards' work for the same sample countries and time period as in his study. Second, we extend Edwards' work by taking into account a country's stage of development, which is captured by a country's stock of human capital and the standard of infrastructure. Finally, we delineate sample countries into three groups according to their income per capita, and examine the impact of openness on productivity growth separately for the three groups.

4.2 Openness Indicators

As mentioned earlier, Edwards' study employs nine different openness indicators to analyse the robustness of the impact of openness on growth. This is following his argument that "the difficulties in defining satisfactory summary indexes suggest that researchers should move away from this area, and should instead concentrate on determining whether econometric results are robust to alternative indexes" (Edwards, 1998, pp 386). Edwards' approach to use different indicators could be due to the assumption that the rudimentary character of some of the indicators would not be as relevant as the robustness of the relationship between openness and growth regardless of the way the indicators were derived or measured. Three of the indicators measure openness proper, while the rest measure the degree of trade policy-induced distortions.

The openness indicators:

(1) Sachs-Warner (SW) openness index. This binary indicator categorises countries as open or close based on five criteria. It takes a value of one if the

country is considered to be open and zero otherwise. The average of 1980 – 1990 is computed to generate the summary indicators.
(2) The subjective delineation of trade regimes in the World Development Report 1987 (WDR). Countries are classified into four groups based on their perceived degree of openness.
(3) Edward Leamer's (1988) openness index, which is computed, based on the residuals from regressions of disaggregated trade flows.

The indicators of policy-induced distortion:
(4) The average black market premium (BMP): the average value of black market premium in the 1980s is used as an indicator of distortions in the exports sector. The raw data were obtained from Barro and Lee (1994).
(5) The average import tariffs on manufacturing (TARIFF). These data for 1982 were reported by UNCTAD and obtained via Barro and Lee (1994).
(6) The average coverage of non-tariff barriers, also from UNCTAD as reported in Barro and Lee (1994).
(7) The subjective Heritage Foundation index of distortions in international trade.
(8) Collected trade taxes ratio: the ratio of total revenues on international trade taxes (exports + imports) to total trade (CTR).
(9) Holger Wolf's (1993) regression-based index of import distortions for 1985.

SW, WDR and Leamer are proper openness measures in which a higher value indicates lower policy intervention in international trade. Therefore, the estimated coefficients of these variables are expected to be positive. The rest of six indices, on the other hand, reflect trade distortionary measures, and therefore higher values of these indices indicate that the country under question is pursuing inward-oriented trade policy or is implemented measures that impede free trade. Thus, the estimated coefficients of these variables are expected to be negative.

The results reported in Edwards study are weighted least squares (WLS) of TFP growth on its determinants: (i) log of initial GDP per capita (i.e., GDP per capita in 1965); (ii) initial level of human capital (secondary school enrolment in 1965); and (iii) openness indexes discussed above entering the regression separately. The weighting variable in this regression is 1985 GDP per capita. The estimated results are presented in Table 4.5. The estimated results show that all have the expected sign, and five openness indicators are statistically significant. The results confirm that distortionary trade policies have a negative impact on growth. Based on these findings Edwards concludes, "... more open countries have indeed experienced faster productivity growth" (1998, p 372).

4.3 Replication of Edwards' Model

The regression analysis of TFP growth includes 93 both developed and developing countries (see appendix 3 for the list). In this model total factor productivity growth are the Solow residuals which are obtained from a panel estimation of GDP growth. Therefore, the first step of the analysis is to estimate growth of real GDP on growth rates of physical capital and labour inputs for which the data set were obtained from Nehru and Dhareshwar (1993). The following equation was estimated using a panel data set for 1960 - 1990:

$$y_{it} = \alpha d \log K_{it} + \beta d \log L_{it} + \lambda + \zeta_t + \varepsilon_i + \mu_{it} \quad , \qquad (4.1)$$

where ζ, ε and μ are a time specific, country specific and common i.i.d error terms; and λ is a common fixed effect term. The sum of α and β is assumed to be equal to one (which essentially follows from the assumption that production functions are homogenous of degree one).

We replicate Edwards' regression results first by using the same sample of countries and time period. Then we demonstrate that the results do not hold for a sample of countries that are at low stages of development. We will examine the robustness of these results and show that, to a large extent, the applicability of Edwards' finding is limited to certain groups of countries. We will also analyse how the endowment of human capital and level of infrastructure play a key role in the diffusion of technology across countries.

Our starting point is, as in the case of Edwards' work, estimation of a random effect GDP growth equation using panel data for 1960 –1990. The data set for real GDP, physical capital and labour were obtained from the same source, i.e., Nehru and Dhareshwar (1993). We regressed real GDP against growth rate of physical capital and labour input to construct annual estimates of TFP growth from the estimated shares of factors of production. We then computed the average TFP growth for 1980-1990 to estimate the cross-section impact of openness on TFP growth. We computed a correlation test against Fischer's (1993) TFP data set to determine the consistency of our results with other studies. The estimated correlation coefficient is 0.63, which is high enough to consider our TFP growth data set is consistent with those of other studies.

Because of the outlier effect of Iraq, which has an average of -13 percent TFP growth in the 1980s, Edwards removed it from the regression analysis. Therefore, we also dropped Iraq from our sample. In addition, because of lack of data we removed Libya from our empirical analysis. A summary of the estimates of TFP growth for 1960 –1990 and 1980 – 1990 are shown in Table 4.1.

The figures in Table 4.1 suggest that, on average, there was slow productivity in the 1980s. The standard deviation figure also implies that TFP growth differences between countries were higher in the 1980s. These results are consistent with those of Edwards'.

Table 4.1

TFP growth estimates: Summary Statistics

	TFP 1960 –1990	TFP 1980 - 1990
Average	0.008	0.004
Standard Deviation	0.01	0.03

Source: own calculation

4.3.1 Regression results

As in the case of Edwards' study, we consider three basic determinants of TFP growth in our regression analysis: log of initial GDP per capita (GDP65), log of initial level of human capital (HK65) and six openness indices which enter the estimated equation separately. Because of lack of data we employ only six out of nine openness indicators used in Edwards' study: Sachs-Warner (SW), Leamer and World Development Report (WDR) measure openness proper, while TARIFF, black market premium (BMP) and collected trade taxes ratio (CTR) measure the degree of trade-policy induced distortions. Data on TARIFF and CTR (which were not available to Edwards at the time of his study) are different. Note that Edwards do not present the details of countries included in each regression, therefore we included as many countries as we can depending on data availability (see Appendix 11 for definition and sources of data).

According to Sachs and Warner (1995), countries with restrictive trade policies take value of zero, while those with liberal trade policy take a value of one. In its annual report World Bank, World Development Report (1987), delineated 41 countries into four groups: strongly outward oriented, moderately outward oriented, moderately inward oriented and strongly inward oriented (see Appendix 4 for the classified list of countries and page 46 for the criteria used to determine the openness of the countries under investigation).

Leamer (1988) regressed export flows against its possible determinants: physical capital, labour, oil production (value of oil and gas production), coal production (value of coal production), minerals (value of production of minerals), distance (GNP-weighted average distance to market), and trade balance. The average residuals were taken as openness indicators. The higher values imply more open economies. According to Leamer's calculation Iceland is the most closed economy with a value of -2.8, while Belgium scores 0.22 as the most open economy (see Chapter 3, page 44 for detail on the procedure used to determine a country's openness).

Table 4.2:

Statistical summary of openness indicators

Openness Indicators	No. of Observations	Mean	Standard Deviation	Minimum	Maximum	Period
SW	63	0.36	0.44	0	1	1980-1990
WDR	32	1.97	0.88	1	4	1973-1985
Leamer	49	-0.32	0.63	-2.8	0.22	1982
BMP	82	0.59	1.54	0	14.01	1980-1990
Tariffs	85	0.13	0.11	0.02	1.43	1982
CTR	85	0.05	0.08	0.001	0.19	1980-1985

Source: own calculation

The number of observations, for each estimated equation, vary (ranging from 32 - 85), depending on availability of data. Table 4.2 presents statistical summary of the openness indicators used in our regression analysis. Higher values of SW, WDR and Leamer imply more open economies, while high values of BMP, Tariffs and CTR imply high intervention and trade distortion policies. As can be seen from Table 4.2, there is a significance difference in the extent of trade distortions.

We computed a simple correlation test on our openness indicators and found that the indices reflect somewhat similar myth in the face of their significant differences with respect to their background. Table 4.3 presents the simple correlation test results between the six openness indicators employed in the analysis. All have the expected signs with values ranging from 0.23 to 1, in absolute value.

We begin our analysis on the estimation of TFP growth by examining the effects of initial level of GDP (i.e., income per capita in 1965, and denoted as GDP65), initial level of human capital (schooling in 1965)[1], and the openness indicators.

Table 4.3:

Correlation between openness indicators

	SW	WDR	Leamer	BMP	Tariffs	CTR
SW	1					
WDR	0.61	1				
Leamer	0.53	0.36	1			
BMP	-0.48	-0.23	-0.29	1		
Tariffs	-0.57	-0.64	-0.30	0.33	1	
CTR	-0.44	-0.50	-0.38	0.28	0.73	1

Source: own calculation.

Tables 4.4 - 4.12 present the WLS regression results for various specifications. The sample size varies in each regression depending on data availability for trade policy measures. The following conclusions can be drawn

[1] We used the ratio of public expenditure on education to GDP as an alternative measure of human capital, and the results are fairly close and similar.

Table 4.4

Weighted Least Square Regression for full sample countries

Dependent Variable: TFP Growth, 1980–1990

		Edwards' Results					Own Results							
	Openness Measure	ln GDP65	ln HK65	Trade Orientation	N	R^2	Con.	ln GDP65	ln HK65	Trade Orientation	N	R^2	F-value	White
1	SW	-0.011** (-2.41)	0.005*** (3.27)	0.0094* (2.12)	51	0.24	0.003 (2.37)	-0.006* (-2.29)	0.002** (2.68)	0.006* (2.15)	63	0.39	7.85	4.59
2	WDR	-0.013 (-2.53)	0.004* (2.17)	0.0075*** (3.67)	32	0.45	0.001 (2.08)	-0.017** (-2.56)	0.004* (2.21)	0.006*** (3.55)	32	0.47	8.12	2.16
3	Leamer	-0.005 (-0.90)	0.003 (1.94)	0.0041 (1.03)	44	0.23	0.004 (1.96)	-0.007 (-1.14)	0.002 (1.89)	0.005 (1.08)	49	0.22	4.07	2.57
4	BMP	-0.008** (-2.43)	0.003** (2.53)	-0.022*** (-3.59)	75	0.28	0.002 (2.15)	-0.005** (-2.37)	0.002** (2.44)	-0.04*** (-3.20)	82	0.25	4.62	4.28
5	TARIFF	-0.01** (-2.69)	0.003*** (2.99)	-0.045*** (-2.77)	67	0.24	0.002 (2.28)	-0.005** (-2.41)	0.001** (2.67)	-0.002* (-1.96)	85	0.30	9.22	3.91
6	CTR	-0.017*** (-3.24)	0.004*** (3.34)	-0.048*** (-3.04)	45	0.34	0.003 (2.34)	-0.008** (-2.38)	0.0012** (2.46)	-0.01** (-2.51)	85	0.36	5.94	3.86

Notes: GDP per capita in 1965 and schooling in 1965 entered the equation in the log form. Each row corresponds to a TFP growth regression using a different openness indicator. The indicator being used is identified in column 2. SW is a binary index which takes a value of 1 if the country is considered to be open in that particular year, and zero if it is closed. WDR is openness index ranges between 0-4. Leamer is openness index developed by Leamer 1988). *TARIFF is the average tariff for 1982.* Collected Trade Taxes Ratio (CTR) *is the average for 1980-85 of the* ratio of total revenues on taxes on international trade (import plus exports) to total trade. BMP is the average value of the black market premium in the foreign exchange rate market during the 1980s. All the regressions were estimated using weighted least squares (GDP per capita in PPP dollars in 1985 was used as a weight). Figures in parentheses are t-values.*** Significant at the 1 % level; ** significant at the 5 % level; and * significant at the 10 % level

from the estimated results. The R^2s in Table 4.4 suggest that the models have a good fit for most samples and are broadly of the same order as reported in similar cross-section studies. The F-values are significant at the conventional levels in every case, and the fit is equally good for all models. The White test indicate that we accept the null hypothesis for homoschedasticity in each regression. In all samples, the estimated coefficients of initial per capita GDP (GDP65) are negative as expected, and in most cases they are significant at conventional levels supporting the argument that countries with a low initial level of income tend to grow faster. The initial level of human capital (HK65), on the other hand, is positive and statistically significant in five out of six estimated equations, implying that countries with a high initial level of human capital endowment tend to capture new technology developed in the advanced countries through international trade.

As can be seen from Table 4.4, there is a fair degree of similarity between our results and the results reported in Edwards (1998) despite the differences in the number of observations used in some of the regressions. For example, in row 1 of Table 4.4, the coefficient and t-value of lnGDP65 in Edwards' regression are -0.011 and -2.4, respectively. The corresponding figures in our regression are -0.005 and -2.29. In the same row, openness indicator (SW) has a coefficient of 0.0084 with t-ratio of 2.12 in Edwards regression, while in our regression we obtained a coefficient of 0.006 and 2.05 t-ratio. Thus, although we include different number of observations, the difference in the estimated values is negligible. There is, however, significant difference in both the estimated coefficient and t-value of TARIFF and CTR. In the case of TARIFF, the results in Edwards' regression show that has a coefficient of -0.045 with t-ratio of -2.77, indicating it is significant at 1% level. Whereas, in our regression we obtained a coefficient of -0.002 with a t-value of -1.96, which is significant at only 10%. Similarly, the estimated coefficient of CTR in Edwards' regression is -0.048 with a t-ratio -3.04, which is significant at 1% level. The corresponding figures in our regression are -0.03 and -2.51, respectively, it is significant at only 5% level. This, we think is mainly due to the type of data and the difference in the number of observations used.[2] All of the six openness indicators (SW, WDR, Leamer, BMP, TARIFF and CTR) hold the expected signs, and with the exception of Leamer, five of them are statistically significant at conventional levels.

[2] As discussed earlier, Edwards used average import tariff on manufacturing, where as we use average import duties as a proportion of total imports as reported in World Bank (2000).

Table 4.5
Weighted Least Square Regression for full sample of countries with level of development indicators

Dependent Variable: TFP Growth, 1980-1990

Openness Indicators		Constant	lnGDP65	lnHK65	Trade Orientation	lnHK	lnInfra	N	R^2	F-value	White
SW	1	0.011 (2.51)	-0.005^{*} (-2.27)	0.002^{**} (2.63)	0.006^{*} (2.19)	0.05^{***} (2.76)	0.03^{**} (2.53)	63	0.43	12.10	7.71
WDR	2	0.005 (2.27)	-0.02^{**} (-2.58)	0.003^{*} (2.16)	0.005^{***} (3.49)	0.02^{***} (2.71)	0.005^{**} (2.66)	32	0.61	21.25	4.19
Leamer	3	0.01 (2.19)	-0.007 (-1.16)	0.001 (1.81)	0.007 (1.24)	0.02^{**} (2.40)	0.008^{**} (2.34)	49	0.39	8.94	3.63
BMP	4	0.008 (2.43)	-0.005^{**} (-2.38)	0.002^{**} (2.42)	-0.05^{***} (-3.26)	0.06^{***} (2.82)	0.02^{**} (2.48)	82	0.37	10.21	8.80
Tariffs	5	0.004 (2.40)	-0.006^{**} (-2.47)	0.002^{**} (2.30)	-0.005^{*} (-2.11)	0.03^{**} (2.64)	0.03^{**} (2.56)	85	0.46	16.11	8.28
CTR	6	0.006 (2.53)	-0.008^{**} (-2.36)	0.003^{**} (2.48)	-0.04^{**} (-2.63)	0.04^{***} (2.70)	0.03^{**} (2.55)	85	0.52	12.71	7.11

Note: Figures in parentheses are t-values. •••, •• and • denote respectively the 1 percent, 5 percent and 10 percent level of significance. Each row corresponds to a TFP growth regression using a different trade policy indicator. The indicator being used is identified in column 1, and its estimated coefficients appear in column 4 under trade orientation. White is heteroschedasticity test.

Table 4.5 presents regression results that incorporate human capital and infrastructure variables that we want to control for as proxies for stages of development. Adding human capital and infrastructure variables in the regression caused the significance level as well as the coefficients of some of the parameters to alter, although the change is minimal in most cases. However, in addition to substantial increase in the R^2 value (which is a sign for a better fit of the estimated relationship of the model), the explanatory power of all of the openness indicators, with the exception of BMP, became higher. This seems to indicate that human capital and infrastructure have significant role in determining the effect of openness on growth. In all regressions human capital and infrastructure variables are positive and statistically significant at conventional levels. For example, a 1% increase in stock of human capital (row 1 and column 5 of Table 4.5) would enhance TFP growth by 0.05%. Similarly, a 1% increase in level of infrastructure would lead TFP growth by 0.03%. This implies that human capital and infrastructure play an important role in the growth process of sample countries.

The results reported in Tables 4.4 and 4.5 provide some robust evidence in support of the hypothesis that more open economies tend to experience higher TFP growth rate than those who pursue restrictive trade regimes. It is also reveals that the level of development indicators play a significant role in explaining TFP growth and that the impact of openness measures included in the regression, and dependent upon human capital and infrastructure as their inclusion in the regression altered the explanatory power of the variables.

4.3.2 Empirical results with separate sample of countries

The previous section provides evidence supporting the hypothesis that relatively more open economies tend grow faster than those pursuing restrictive trade policy. However, the data set used in the above regression includes a mixture of both developing and developed countries. Therefore, we must now address the question whether the impact estimated across the whole sample still holds for the separate groups of countries. The necessary step is to extend the regression analysis by dividing the sample countries into three groups. The sample of 89 countries are divided into three groups – one consisting of 26 countries with a 1985 per capita income of above $9000, the second group consisting of 34 countries with income per capita in 1985 of between $700 and $9000, and the third group consisting of 29 countries with income per capita income of $700 or less (see Appendix 5 for the list). As the World Development Report (1987) classification of countries only includes 41 middle- and low-income countries, WDR variable is not included in the regressions that we run for the separate groups of countries. The results are presented in Tables 4.6-4.8.

Table 4.6

Weighted Least Square Regression for a sample of high-income countries (with and without level of development indicators)

Dependent Variable: TFP Growth, 1980-1990.

Openness Indicators		Constant	ln GDP65	ln HK65	Trade Orientation	ln HK	ln INFRA	N	R^2	F-value	White
SW	1	0.02 (2.19)	-0.06*** (-2.91)	0.03*** (3.17)	0.02** (2.61)			20	0.47	4.25	1.35
	2	0.03 (2.44)	-0.06*** (-2.87)	0.02*** (3.10)	0.04*** (2.80)	0.08*** (2.93)	0.05*** (2.74)	20	0.56	7.57	1.60
Leamer	3	0.004 (1.82)	-0.01* (-2.15)	0.005* (2.37)	0.006 (1.17)			19	0.20	3.39	1.48
	4	0.007 (2.27)	-0.01* (-2.16)	0.003* (2.24)	0.006 (1.19)	0.06*** (2.81)	0.04** (2.68)	19	0.27	5.91	1.73
BMP	5	0.01 (2.26)	-0.04*** (-2.70)	0.03*** (2.84)	-0.0002 (-1.02)			19	0.24	2.98	1.39
	6	0.03 (2.48)	-0.04** (-2.68)	0.02*** (2.75)	-0.0001 (-0.96)	0.04*** (2.70)	0.03** (2.61)	19	0.32	5.09	1.64
TARIFF	7	0.05 (2.37)	-0.02** (-2.63)	0.008*** (2.82)	-0.02** (-2.45)			23	0.43	5.28	1.87
	8	0.06 (2.55)	-0.01** (-2.58)	0.006*** (2.73)	-0.04** (-2.61)	0.05*** (2.83)	0.04*** (2.70)	23	0.58	6.14	2.13
CTR	9	0.04 (2.30)	-0.01*** (-2.81)	0.007*** (2.79)	-0.05*** (-2.85)			23	0.37	3.72	1.94
	10	0.05 (2.56)	-0.01*** (-2.82)	0.006*** (2.72)	-0.06*** (-2.89)	0.061*** (2.77)	0.04** (2.67)	23	0.56	6.29	2.18

*Note: Figures in parentheses are t-values. ***, ** and * denote respectively the 1 percent, 5 percent and 10 percent level of significance. Each row corresponds to a TFP growth regression using a different trade policy indicator. The indicator being used is identified in column 1, and its estimated coefficients appear in column 4 under trade orientation. With the exception of S-W the remaining openness variables enter in the regression in natural logs. White is heteroschedasticity test.*

With respect to high-income countries the R^2s in most regressions indicate that a fair proportion of the changes in TFP growth is explained by the independent variables. F-test statistics also show that the explanatory variables are jointly significant. The White test suggests that we accept the null hypothesis for homoschedasticity in all regressions. The regression results obtained for high-income countries provide more evidence that openness has significant positive impact on growth. With the exception of Leamer and BMP the other three variables are significant at conventional levels. Actually, Leamer is not significant in the full sample regression as well. And it is not surprising to find an insignificant estimated coefficient for BMP, as the value of black market premium is negligible in developed countries, if there is any. The results reported in Table 4.6, also include the estimated equations that incorporated human capital and infrastructure variables. Following the inclusion of human capital and infrastructure, the explanatory power of the rest of the openness related variables has also increased in all cases, with higher changes observed in the case of TARIFF variable.

From the regression results for middle-income countries (see Table 4.7), we can in general infer that there is a positive association between openness and TFP growth. Nevertheless, as can be seen from Table 4.7 only four (SW, TARIFF, BMP and CTR) of the six openness indicators were found to be statistically significant at conventional levels. As in high-income countries, middle-income countries seem to benefit from openness. For example, a 10% tariff cut would stimulate TFP growth by 0.05%. However, the comparative figure for high-income countries is much higher. That is, a 10% tariff cut in high-income countries would lead TFP growth by 1%. This can be considered as an indicative that there is a significant difference in the impact of openness measures among different group of countries with different level of development. The estimated coefficients of human capital and infrastructure are positive and significant at conventional levels. The effect of human capital seems to be slightly greater in middle-income countries than high-income countries. In general, the results show that human capital and infrastructure play significant roles in the process of growth of middle-income countries. Furthermore, when controlling for human capital and infrastructure, most of openness related variables altered. For example, in row 10 and column 4 of Table 4.7, the magnitude of CTR variable has increased from 0.2 to 0.3 with an increase in the t-ratio from -2.48 to -2.53.

Table 4.7
Weighted Least Square Regression for a sample of middle-income countries (with and with level of development indicators)
Dependent Variable: TFP Growth, 1980-1990

Openness Indicators	Eq. No.	Constant	lnGDP65	lnHK65	Trade Orientation	ln HK	ln INFRA	N	R^2	F-test	White
SW	1	0.002 (1.96)	-0.007* (-2.04)	0.004** (2.52)	0.003* (2.21)			19	0.41	2.87	2.37
	2	0.004 (2.29)	-0.007* (-2.06)	0.003** (2.47)	0.004* (2.28)	0.03*** (2.72)	0.001** (2.57)	19	0.49	3.91	2.69
Leamer	3	0.001 (1.56)	-0.003 (-1.81)	0.001 (1.86)	0.01 (1.35)			30	0.44	3.31	1.96
	4	0.003 (1.87)	-0.003 (-1.80)	0.001 (1.82)	0.02 (1.40)	0.008** (2.41)	0.006* (2.19)	30	0.50	5.02	2.11
BMP	5	0.03 (2.19)	-0.006* (-2.13)	0.001** (2.41)	-0.05* (-3.06)			34	0.54	4.28	2.40
	6	0.06 (2.37)	-0.005* (-2.10)	0.001** (2.40)	-0.04 (-2.98)	0.04** (2.69)	0.01** (2.51)	34	0.59	7.19	2.73
Tariffs	7	0.04 (2.31)	-0.008* (-2.19)	0.004** (2.46)	-0.005 (-1.94)			34	0.41	3.08	2.34
	8	0.07 (2.58)	-0.008* (-2.18)	0.003** (2.40)	-0.007* (-2.07)	0.04** (2.61)	0.013** (2.55)	34	0.46	4.22	2.67
CTR	9	0.04 (2.27)	-0.007* (-2.12)	0.003** (2.42)	-0.02* (-2.48)			34	0.38	6.14	2.19
	10	0.05 (2.46)	-0.007* (-2.15)	0.003** (2.41)	-0.03** (-2.53)	0.02** (2.58)	0.02** (2.34)	34	0.44	8.51	2.72

*Note: Figures in parentheses are t-values. ***, ** and * denote respectively the 1 percent, 5 percent and 10 percent level of significance. With the exception of SW the remaining openness variables enter in the regression in natural logs. White is heteroschedasticity test.*

The regression results for the low-income countries are presented in Table 4.8. Now a dramatically different story is revealed. In most regressions the initial level of income per capita is significant at conventional levels, implying that there exists conditional convergence across low-income countries. The initial level of human capital gives some mixed results as it appears to be significant only at the 10% level in most cases. This could be due to that fact that the 1965 level of human capital of low-income countries might not be adequate to have a positive impact on the growth process. The results show that there is no evidence to support the hypothesis that outward orientation is associated with growth performance of the low-income countries. The estimated results show that there is no significant link between Sachs-Warner openness indicator and TFP growth.

Table 4.8
Weighted Least Square Regression for a sample of low-income countries

(with and without level of development indicators)
Dependent Variable: TFP Growth, 1980-1990.

Openness Indicators	Eq. No.	Constant	ln GDP65	ln HK65	Trade Orientation	ln HK	ln Infra	N	R^2	F-test	White
SW	1	-0.001 (-1.27)	-0.003* (-1.96)	0.002* (2.15)	0.0003 (1.59)			19	0.41	3.11	2.76
	2	0.004 (1.82)	-0.003* (-1.98)	0.002* (2.12)	0.0005 (1.67)	0.01* (2.46)	0.0013* (2.15)	19	0.47	4.20	2.98
BMP	3	0.001 (1.57)	-0.002 (-1.91)	0.001* (1.98)	-0.003** (-2.59)			29	0.45	2.95	2.61
	4	0.005 (1.93)	-0.001 (-1.88)	0.001* (1.96)	-0.003** (-2.60)	0.008** (2.37)	0.006* (2.26)	29	0.53	4.29	2.84
TARIFF	5	0.002 (1.63)	-0.002* (-1.95)	0.003* (2.19)	0.002** (2.44)			28	0.39	3.56	3.09
	6	0.005 (1.91)	-0.002* (-1.94)	0.0021* (2.14)	0.002** (2.50)	0.007** (2.42)	0.003* (2.23)	28	0.48	4.91	3.28
CTR	7	0.001 (1.75)	-0.002* (-1.96)	0.002 (1.93)	0.003* (2.16)			28	0.51	4.24	3.15
	8	0.003 (1.87)	-0.002* (-1.96)	0.001 (1.89)	0.003* (2.21)	0.008** (2.39)	0.002* (2.29)	28	0.66	5.61	3.37

*Note: Figures in parentheses are t-values. ***, ** and * denote respectively the 1 percent, 5 percent and 10 percent level of significance. With the exception of SW the remaining openness variables enter in the regression in natural logs.*

Most revealing is the finding that TARIFF and CTR have positive coefficients that are significant at 5% and 10 % levels respectively. The only variable with the expected sign that is statistically significant is black market premium (BMP). However, this could be mainly due to the fact that there is a stringent foreign exchange policy in low-income countries because of severe shortage of foreign currency. Consequently, demand for foreign currency exceeds the supply side of it resulting the existence of a foreign currency black market, where the shadow price of the domestic currency reflects a discount (premium) and is normally lower (higher) than the official foreign exchange rate. The main implication of these results is that for the low-income countries, foreign exchange policy matters more than other policies that are associated with free trade.

Table 4.8 also presents estimated results that include human capital and infrastructure variables to determine their impact in the process of knowledge spillover. While incorporating human capital and infrastructure variables does have significant impact to increase the R^2, the estimated coefficients for both human capital and infrastructure are positive and statistically significant. After human capital and infrastructure variables are included in the regression (equation 2 of Table 4.8) both the coefficient and t-value of Sachs-Warner variable have increased, although it still remains insignificant. The black market premium variable hasn't changed significantly when the two variables are included. In the case of both TARIFF and CTR the estimated coefficients as well as t-values increased following the inclusion of human capital and infrastructure variables (equations 6 and 8 of Table 4.8). The overall implication of these results is that in the case of low-income countries openness (as measured by the variables used in the regression) does not lead to a higher rate of economic growth. Drawing upon the positive effect of human capital and infrastructure, it can be suggested here that low-income countries should concentrate more on their investment on education and infrastructure, which eventually will allow them to be able to absorb foreign technology through trade, and also to attract foreign investment that will bring capital goods which embody new technology.

The proposition regarding the close relationship between openness and economic growth performs quite differently in the three samples of countries. In the sphere of policy debate, Edwards' results and other earlier empirical findings bear heavily on the universal applicability of outward-oriented policy. Our results demonstrate that the significance of openness coefficients vary across groups of countries, casting serious doubt on the desirability of pooling all countries together in empirical analysis irrespective of their levels of development. Therefore, the universal recommendation of openness under these circumstances is highly questionable.

4.3.3 Empirical results with different sample periods

Following the results obtained in the previous section that suggest openness is not positively associated with growth of low-income countries, we consider to extending our analysis further for a sample of 66 middle- and low-income countries but different periods 1975-1985 and 1985-1995. The countries included in this particular analysis are listed in appendix 6. Data on Tariffs and CTR were taken from World Bank's World Development Indicators (2000. Data on Sachs-Warner and BMP were obtained from Sachs and Warner (1995). Human capital and infrastructure data were also taken from World Development Indicators (2000). We selected these time periods for three major reasons: first, it is our aim to avoid any potential econometric bias arising as a result of the 1973 oil price shock; second, most developing countries carried out policy reforms starting from late 1980s; and finally, since countries are assumed to acquire some development from one period to another, we intend to examine if this has had some impact on the effect of openness in the process of economic growth.

Table 4.9 contains the main regression results for the entire sample (middle- and low-income countries) for sub-periods 1975-1985 and 1985-1995. A number of points could be discerned from these results. First, in all cases, the initial level of GDP (GDP65) has negative and statistically significant coefficients reaffirming the income convergence hypothesis. The initial level of human capital, as expected, maintained the positive sign and is significant at conventional levels. Moreover, the estimated coefficients of openness indicators (in both sub-periods) maintain the expected sign, and, with the exception of TARIFF, all are statistically significant. These results support the hypothesis that more open economies tend to grow faster. We should, however, emphasise here that in most of the regression results the inclusion of human capital and infrastructure strengthen the models. Furthermore, the impact of

Table 4.9 Weighted Least Squares Regression for developing countries (middle- and low-income countries)

Dependent variable: TFP growth, 1975-85 and 1986-95

	Eq. No.	Constant	Log GDP75	Log HK75	SW	BMP	TARIFF	CTR	ln HK	ln INFRA	R^2	N	F-stat	White
1975-1985	1	0.001 (1.92)	-0.003 (-2.26)	0.002 (2.34)	0.001 (1.78)						0.38	47	6.71	5.16
	2	0.004 (2.37)	-0.003 (-2.27)	0.001 (2.30)	0.002 (1.85)				0.02 (2.60)	0.007 (2.26)	0.49	47	10.13	7.66
	3	0.003 (2.08)	-0.002 (-2.21)	0.003 (2.28)		-0 006 (-3.12)					0.33	66	5.07	6.13
	4	0.007 (2.51)	-0.003 (-2.25)	0.001 (2.23)		-0.005 (-3.29)			0.01 (2.51)	0.003 (2.17)	0.39	66	8.11	9.21
	5	0.004 (2.40))	-0.004 (-2.34)	0.003 (2.39)			-0.0002 (-1.49)				0.30	64	6.49	5.29
	6	0.002 (2.19)	-0.004 (-2.33)	0.002 (2.35)			-0.0004 (-1.71)		0.02 (2.71)	0.001 (2.40)	0.36	64	5.71	8.36
	7	0.005 (2.41)	-0.005 (-2.38)	0.001 (2.31)				-0.0005 (-1.87)			0.31	64	6.30	4.97
	8	0.001 (2.63)	-0.005 (-2.38)	0.001 (2.30)				-0.001 (-1.95)	0.02 (2.68)	0.0008 (2.36)	0.38	64	11.9	7.28
1986-1995	9	0.004 (2.18)	-0.005 (-2.43)	0.002 (1.98)	0.002 (2.04)						0.35	47	6.01	5.82
	10	0.006 (2.30)	-0.005 (-2.40)	0.001 (1.94)	0.002 (2.09)				0.04 (2.76)	0.01 (2.43)	0.42	47	5.83	9.24
	11	0.003 (2.21)	-0.004 (-2.23)	0.001 (2.07)		-0.03 (-2.86)					0.39	66	3.48	5.48
	12	0.004 (2.49)	-0.003 (-2.19)	0.001 (2.04)		-0.03 (-2.84)			0.02 (2.54)	0.01 (2.40)	0.46	66	7.22	8.17
	13	0.005 (2.58)	-0.006 (-2.27)	0.002 (2.11)			-0.0005 (-1.87)				0.40	64	6.91	6.51
	14	0.007 (2.71)	-0.006 (-2.26)	0.001 (2.08)			-0.001 (-1.95)		0.03 (2.40)	0.01 (2.33)	0.49	64	10.01	9.34
	15	0.01 (2.64)	-0.005 (-2.38)	0.003 (2.15)				-0.002 (-2.13)			0.32	64	5.85	5.83
	16	0.03 (2.79)	-0.004 (-2.32)	0.002 (2.12)				-0.003 (-2.17)	0.03 (2.52)	0.01 (2.47)	0.40	64	6.47	8.67

Note: Figures in parentheses are t-values. ln GDP75 and ln HK^% denote the initial levels of per capita income and human capital, respectively. With the exception of SW all openness indicators enter in the regresssion in natural logs. White is heterschedasticity test.

Table 4.10 Weighted Least Squares Regression for a sample of middle-income countries

Dependent variable: TFP growth, 1975-85 and 1986-95

	Eq. No.	Constant	ln GDP75	ln HK75	SW	BMP	TARIFF	CTR	ln HK	Ln INFRA	R^2	N	F-stat	White
1975-1985	1	0.001 (1.59)	-0.005 (-2.58)	0.005 (2.61)	0.002 (1.89)						0.44	26	4.68	2.48
	2	0.004 (2.19)	-0.004 (-2.51)	0.004 (2.49)	0.004 (1.97)				0.05 (2.71)	0.01 (2.43)	0.51	26	8.25	3.19
	3	0.003 (1.94)	-0.004 (-2.45)	0.006 (2.39)		-0.08 (-3.55)					0.46	35	5.15	1.36
	4	0.005 (2.27)	-0.004 (-2.42)	0.004 (2.31)		-0.08 (-3.49)			0.07 (2.76)	0.02 (2.47)	0.50	35	6.27	2.06
	5	0.002 (1.84)	-0.005 (-2.63)	0.006 (2.45)			-0.001 (-1.82)				0.38	35	4.53	2.12
	6	0.004 (2.27)	-0.004 (-2.58)	0.005 (2.40)			-0.002 (-1.92)		0.04 (2.66)	0.008 (2.36)	0.49	35	8.21	2.27
	7	0.001 (1.73)	-0.005 (-2.56)	0.005 (2.43)				-0.003 (-2.05)			0.32	35	4.57	1.72
	8	0.003 (2.15)	-0.005 (-2.57)	0.004 (2.38)				-0.003 (-2.03)	0.06 (2.71)	0.01 (2.49)	0.44	35	8.02	2.11
1986-1995	9	0.004 (2.24)	-0.008 (-2.42)	0.003 (2.17)	0.005 (2.25)						0.41	26	5.25	1.53
	10	0.006 (2.53)	-0.006 (-2.36)	0.001 (2.09)	0.006 (2.34)				0.07 (2.84)	0.03 (2.58)	0.60	26	4.33	1.92
	11	0.002 (2.14)	-0.007 (-2.39)	0.003 (2.23)		-0.04 (-2.98)					0.38	35	3.98	2.05
	12	0.003 (2.20)	-0.005 (-3.31)	0.002 (2.15)		-0.04 (-2.95)			0.06 (2.59)	0.02 (2.56)	0.45	35	8.30	2.29
	13	0.006 (2.59)	-0.008 (-2.46)	0.003 (2.18)			-0.004 (-2.27)				0.45	35	7.53	1.88
	14	0.01 (2.73)	-0.007 (-2.41)	0.002 (2.13)			-0.005 (-2.34)		0.07 (2.63)	0.02 (2.50)	0.62	35	8.28	1.90
	15	0.005 (2.35)	-0.008 (-2.50)	0.003 (2.21)				-0.0012 (-2.13)			0.38	35	5.36	2.16
	16	0.007 (2.50)	-0.008 (-2.47)	0.001 (2.15)				-0.003 (-2.17)	0.08 (2.70)	0.03 (2.59)	0.51	35	8.14	2.27

Note Figures in parentheses are t-values. ln GDP75 and ln HK75 denote the initial levels of per capita income and human capital, respectively. With the exception of SW all openness indicators enter in the regression in natural logs. White is heteroschedasticity test openness indicators is relatively higher in the second study period than in the first. In the first period (1975-85), with the exception of BMP, all openness indicators are not significant, whereas in the second period (1986-95) they all are significant.

Since the regression results reported in Table 4.9 include both middle- and low-income countries, we need to divide the sample in order to capture to what extent level of development matters in determining the impact of openness on economic growth. Table 4.10 presents the estimated results for middle-income countries. For the period 1975-1985, although all variables maintain the expected sign, BMP and CTR were the only variables to be statistically significant at 5 percent and 10 percent level, respectively. For the second period 1985-1995, all the openness variables included in the regression hold the right sign and they all are statistically significant. Closer look at the changes in the estimated coefficients of the openness indicators as well as GDP65 and HK65 suggest that, between 1985-1995 the impact of human capital and infrastructure is higher. These findings are in line with our hypothesis that the impact of openness on economic growth depends on a country's stage of development. We may also note here that in most cases the initial level of human capital became less significant in the second period than in the first.

A similar regression was computed for low-income countries dividing the data into two sub-periods. As can be seen from Table 4.11, in the first study period in all cases the estimated coefficients of initial level of income maintain the expected sign and it is statistically significant, implying conditional convergence among low-income countries. Out of four openness indicators only BMP appears to have the right sign and it is also statistically significant. TARIFF and CTR, on the other hand, hold positive coefficients, which are significant at 10 percent level. Sachs-Warner holds the right sign although it is not significant at any conventional level. The estimated coefficients of human

Table 4.11 Weighted Least Squares Regression for a sample of low-income countries

Dependent variable: TFP growth, 1975-85 and 1986-95

	Eq. No.	Constant	ln GDP75	ln HK75	SW	BMP	TARIFF	CTR	ln HK	lnINFRA	R^2	N	-stat	hite
1975-1985	1	-0.002 (-0.859)	-0.002 (-2.11)	0.002 (2.26)	0.0007 (1.15)						0.36	21	3.84	2.08
	2	0.001 (0.261)	-0.001 (-2.07)	0.001 (2.18)	0.0005 (1.27)				0.008 (2.34)	0.005 (2.12)	0.42	21	4.01	2.91
	3	-0.001 (-0.619)	-0.002 (-2.13)	0.001 (2.29)		-0.04 (-2.96)					0.33	31	3.57	2.15
	4	0.002 (0.795)	-0.002 (-2.11)	0.001 (2.16)		-0.04 (-2.93)			0.006 (2.16)	0.003 (1.95)	0.36	31	3.90	2.39
	5	-0.003 (-1.18)	-0.003 (-2.18)	0.002 (2.27)			0.002 (2.38)				0.28	29	5.20	3.40
	6	-0.001 (-0.527)	-0.003 (-2.19)	0.001 (2.09)			0.001 (2.26)		0.008 (2.42)	0.004 (2.19)	0.31	29	7.34	5.18
	7	-0.002 (-0.930)	-0.003 (-2.24)	0.001 (2.10)				0.001 (2.15)			0.30	29	5.71	3.31
	8	0.001 (0.283)	-0.002 (-2.19)	0.001 (2.06)				0.0008 (2.03)	0.008 (2.46)	0.005 (2.28)	0.35	29	7.28	4.92
1986-1995	9	0.001 (0.552)	-0.005 (-2.28)	0.001 (1.87)	0.001 (1.69)						0.33	21	4.71	2.38
	10	0.003 (1.12)	-0.005 (-2.26)	0.001 (1.91)	0.003 (2.82)				0.01 (2.61)	0.008 (2.33)	0.45	21	5.10	3.04
	11	0.001 (0.637)	-0.004 (-2.19)	0.001 (1.82)		-0.03 (-2.68)					0.40	31	5.03	2.47
	12	0.002 (0.957)	-0.002 (-2.10)	0.001 (1.89)		-0.02 (-2.61)			0.007 (2.43)	0.01 (2.35)	0.49	31	6.51	4.21
	13	0.001 (0.481)	-0.006 (-2.15)	0.002 (1.82)			0.001 (2.17)				0.39	29	4.47	3.50
	14	0.003 (0.807)	-0.005 (-2.12)	0.002 (1.83)			0.0008 (2.11)		0.01 (2.31)	0.006 (2.24)	0.45	29	6.68	5.11
	15	0.001 (0.529)	-0.003 (-2.24)	0.001 (1.95)				0.0003 (2.06)			0.29	29	4.54	3.42
	16	0.002 (0.772)	-0.003 (-2.22)	0.001 (1.95)				0.0003 (1.96)	0.006 (2.36)	0.004 (2.16)	0.37	29	6.08	5.02

Note: Figures in parentheses are t-values. ln GDP75 and ln HK^% denote the initial levels of per capita income and human capital, respectively. With the exception of S-W all openness indicators enter in the regresssion in natural logs. White is heterschedasticity test.

capital and infrastructure variables suggest that these two variables do have significant role in the process of economic growth in developing countries as they are highly significant in all regressions (with higher magnitude in the second period). A closer look at the estimated coefficient of BMP shows that its negative impact is more severe in the first period between 1975 and 1985. The results suggest that the negative impact of TARIFF and CTR seem to be common only to high-income and middle-income countries, as the estimated coefficients of the two variables is positive in the case of low-income countries. We need to point out here that the positive impact of both TARIFF and CTR became less significant in the second period than in the first.

The regression results in Table 4.11 suggest that there is no statistically significant correlation between openness and TFP growth for low-income countries. Indeed, tariff which commonly regarded, as restrictive trade policy measures appears to be positively associated with TFP growth these countries. Among openness measures, black market premium appears to be the only variable that explains growth rate variability in low-income countries. As noted earlier and argued by Rodrik (1999), the black market premium merely reflects trade policy of a country.

4.4 TFP growth and foreign aid

In this section we examine the effect of aid on TFP growth, and also its interactive impact with trade policy. We attempt to analyse whether aid helps low-income countries in capacity building. According to World Bank (2000), the average aid flow from various sources to developing countries is about $97 billion per annum, of which over $26 billion is in the form of technical assistance, while $14 billion is in the form of food aid, the remaining fund is allocated between project and programme aid. Low-income countries are the principal recipients (above 75%) of these aid flows. It might be worth noting here that aid is one means of knowledge spillover from donor countries to the recipients. Domestic workers may get the opportunity to learn certain skills from foreign experts who are involved in the projects or programmes. Technological spillover may also occur through the machinery or other equipment assistance.

Empirical findings on the impact of aid on growth is ambiguous. Some studies have found that aid has an adverse effect on growth (Griffin, 1970). For a sample of 22 developing countries, Voivodas (1973) obtained a negative effect of aid on growth, though not statistically significant. Papanek (1973), on the other hand, has found that aid has a positive impact on growth. Using panel data for 13 Asian countries, Dowing and Hiemenz (1983) found that aid has a positive contribution to growth. For sample of African countries, Levy (1988) has found that aid has a significant positive impact on growth.

The positive coefficient of TARIFF and CTR prompted us to examine further their impact from a different standpoint. Since almost all low-income countries receive foreign aid in different forms, we assume that it is one of (if not the main) source of foreign capital flow from developed (donating) countries. Thus, if these countries receive sufficient aid (mainly in respect of financial and/or equipment) from developed countries, it will help them to capacity building. Consequently, they will also be able to benefit by cutting trade barriers. Based on this argument we included the ratio of foreign aid flow in GDP (AID) as an explanatory variable.

Furthermore, we also add the interactive term between AID and TARIFF; and AID and CTR in the regression to investigate the interactive impact on growth of AID with TARIFF and CTR. A number of studies have shown that aid flow has positive impact on growth (see for instance, Hadjimichael et al, 1995; Dollar and Kraay, 1999; Durbarry, Gemmell and Greenaway, 2001). Therefore, in normal circumstances the impact of AID and its interactive term with TARIFF and CTR is expected to be positive.

Table 4.12

Further regression analysis for low-income countries

(Weighted Least Square Regression)

Dependent variable TFP

(AID and its interactive term with TARIFF and CTR)

	1975-1985				1985-1995			
	1	2	3	4	5	6	7	8
Constant	0.002^{*} (2.08)	0.005^{**} (2.38)	0.003^{*} (2.27)	0.005^{**} (2.45)	0.001^{*} (2.24)	0.003^{**} (2.51)	0.003^{**} (2.46)	0.004^{**} (2.63)
ln GDP75	-0.002^{*} (-2.15)	-0.002^{*} (-2.13)	-0.003^{*} (-2.24)	-0.003^{*} (-2.22)	-0.006^{*} (-2.15)	-0.006^{*} (-2.14)	-0.003^{*} (-2.22)	-0.003^{*} (-2.20)
ln HK75	0.001^{*} (2.08)	0.001^{*} (2.07)	0.001^{*} (2.10)	0.001^{*} (2.08)	0.002 (1.83)	0.002 (1.84)	0.001 (1.96)	0.001 (1.96)
ln AID	0.04^{**} (2.69)	0.02^{**} (2.57)	0.06^{***} (2.76)	0.03^{**} (2.61)	0.05^{***} (2.73)	0.03^{**} (2.59)	0.08^{***} (2.81)	0.06^{**} (2.69)
ln TARIFF	0.00^{*} (2.21)	0.007^{*} (2.05)			0.0008^{*} (2.11)	0.0006^{*} (2.02)		
AIDTAR		-0.008^{*} (-2.16)				-0.002^{*} (-2.30)		
ln CTR			0.0009^{*} (2.08)	0.0006 (1.97)			0.0003^{*} (2.07)	0.0001 (1.91)
AIDCTR				-0.0005^{*} (-2.19)				-0.001^{*} (-2.16)
ln HK	0.008^{**} (2.40)	0.008^{**} (2.39)	0.005^{**} (2.46)	0.003^{**} (2.46)	0.01^{*} (2.30)	0.01^{*} (2.28)	0.006^{**} (2.40)	0.005^{*} (2.31)
ln INFRA	0.003^{*} (2.13)	0.003^{*} (2.13)	0.002^{*} (2.25)	0.001^{*} (2.21)	0.006^{*} (2.28)	0.006^{*} (2.24)	0.004^{**} (2.38)	0.003^{**} (2.37)
R^2	0.33	0.36	0.37	0.40	0.50	0.53	0.40	0.42
N	29	29	29	29	29	29	29	29
F-stat	7.22	5.79	6.10	8.82	12.8	16.3	9.84	6.16
White	4.27	3.41	4.35	5.20	4.07	5.19	5.59	7.83

*Note: Figures in parentheses are t-values. ***, ** and * denote respectively the 1 percent, 5 percent and 10 percent level of significance. ln GDP75 and ln HK75 are initial levels of per capita GDP and human capital, respectively .ln CTR is ratio of tax on international trade to total revenue. ln AID is ratio of foreign aid to GDP. Ln TARIFF is ratio of import dutyto total import. AIDTAR is the interactive term between ln AID and ln TARIFF. AIDCTR is the interactive term between ln AID and ln CTR. ln HK is human capital. ln INFRA is infrastructure. White is heteroschedasticity test.*

The regression results that incorporated AID and its interactive terms are reported in Table 4.12. As can be seen from the table, AID holds the expected positive sign in all regressions with a significant impact on growth, which is inline with other findings. TARIFF and CTR, on the other hand, still hold the positive coefficients and they are significant at conventional levels. More interestingly, the interactive terms in both cases (AID*TARIFF) and (AID*CTR) hold the negative coefficients, which are statistically significant at

10% level. This seems to imply that these countries need more foreign help before they consider tariff cuts.

4.5 Conclusions

In this chapter, we have extended Edwards' (1998) model and analysed the impact of openness on productivity growth. Our estimates of total factor productivity are the Solow residuals from the panel regression of rate of growth GDP on growth of labour and capital inputs for the period 1960-1990. We then took a decade average for 1980-1990 to examine the impact of openness using six alternative openness indicators, namely, S-W (the binary index developed by Sachs and Warner, 1995), WDR (the World Bank's subjective classification of trade regime in World Development Report, 1987), Leamer (openness index developed by Edward Leamer, 1988, using average residuals from the regressions of trade flows), BMP (average black market premium), TARIFF (average duties on imports) and CTR (the ratio of total revenues on trade taxes to total trade).

We began the analysis by carrying out cross-section regression for a sample of 91 countries and then divided the sample into three groups on the basis of their per capita income to examine whether the results obtained for full sample of countries hold for countries with different levels of development. We have found that our results for the full sample of countries are in line with Edwards' results, supporting the hypothesis that more open economies tend to grow faster than those who pursue inward-oriented trade policies. Out of six openness indicators, all six maintained the expected sign and five (SW, WDR, BMP, TARIFF and CTR) of them are statistically significant at the conventional levels.

When the sample countries are divided into three groups, the results reveal a different story. With respect to high-income countries, the results provide strong evidence that openness is positively associated with TFP growth. Three out of five openness indicators, namely, SW, TARIFF and CTR are statistically significant at the conventional levels. As in the case of the regression for full sample, Leamer is not statistically significant. BMP also appeared to be insignificant although it holds the expected sign. We interpret this result by noting that the value of black market premium is negligible in high-income countries. With respect to middle-income countries, the results show that openness is positively associated with productivity growth. With the exception of Leamer, the remaining five variables (SW, WDR, BMP, TARIFF and CTR) are significant. This implies that middle-income countries tend to benefit from free trade rather than restrictive trade policies. However, a closer look at the estimated values of the openness indicators indicate that the effect is more pronounced in the high-income countries than in the middle-income countries

In the case of low-income countries the results indicate that there is no significant relationship between openness and productivity growth. BMP is the only openness variable that is statistically significant with the right sign. As noted earlier BMP merely reflects the degree of openness as it may be affected by other factors (such as, shortage of foreign currency in the domestic market, corruption, etc). More interestingly, TARIFF and CTR have positive signs and they are statistically significant. The positive impact of TARIFF and CTR may be explained in terms of their effect on the government revenue which in turn is used for public investment. It is clear that, in low-income countries, a large proportion of the governments' revenue come from the duties on international trade. The other interpretation of the positive sign for TARIFF and CTR would be in relation to the import substitution strategy. Considering the positive sign for these policy variables, it could be argued that import substitution industrialisation is the alternative strategy for low-income countries (this issue is empirically tested and discussed in greater detail in Chapter 5).

In all of the regressions human capital and infrastructure variables hold the expected sign and they are statistically significant. However, their magnitude seems to be greater in the high-income countries than in the middle-income countries, and again their impact is greater in the middle-income countries than in the low-income countries. Moreover, when these variables (HK and INFRA) are included in the regression, the model seems to have improved significantly (as the R^2s have increased) and in most cases with significant increases in the magnitude of the openness variables. The estimated results for the initial level of per capita income indicates that there is significant convergence taking place among high-income countries, while it is weak in the middle-income countries and it hardly exists for the low-income countries.

Based on the results obtained in this chapter, we can only deduce that the positive association of openness with productivity growth is particularly strong among the more developed nations. This seems to suggest hat productivity growth is affected by openness only if countries achieve some level of development in relation to their human capital and quality of infrastructure. Moreover, the results indicate that cross-section analysis, such as Edwards' (1998) that mixes both developed and developing countries in the regression may give misleading results as revealed in this study.

The strategy of economic growth in developing countries seems to have more to do with accumulation of human capital and improving level of infrastructure than increasing the degree of openness. According to our regression results doubling the level of human capital, holding other things constant, would increase the average TFP growth rates approximately by 3%. Developing countries need to focus more on investment on education and infrastructure. Without an adequate stock of human capital, developing countries will not be able to absorb new technologies generated in the advanced nations. It may also be noted here that poor infrastructure makes imitation of new technology by the potential domestic entrepreneurs less feasible.

The empirical evidence indicates that the impact of openness and economic growth is limited to high- and middle-income countries. Although the classification of countries on the basis of their per capita income is arbitrary and does not necessarily reflect the countries' human capital endowment and quality of infrastructure, the empirical evidence sheds some light on how openness operates differently between countries that differ in their level of development. This asserted threshold is essentially a simplifying assumption. One may consider an endogenous threshold in a more complicated way. We think that the results presented here will still hold. This indicates that empirical evidence related to the trade-growth nexus seems to be biased in favour of high-income countries. We may also note here that we do not consider that our estimates of total factor productivity growth are fully accurate measures due to the strong homogeneity assumption in technology across the countries. Nevertheless, we think that the main findings will not alter to different technique used to measure TFP.

CHAPTER 5

Trade, Trade Policy and TFP growth: A Panel Data Analysis

5.1 Introduction

In the previous chapter we have replicated Edwards' (1998) model and empirically shown that the positive association of openness to growth does hold primarily for two groups of countries but does not hold significantly for low-income countries. The failure to use a stratified sample based on levels of per capita income may significantly mislead policy makers into thinking that these results hold universally for all countries. We have seen and cautiously interpreted the unprecedented positive impact of import duties (TARIFF) and tax on trade (CTR)on growth. We have also obtained results that imply strong positive effects of human capital and infrastructure on economic growth. Moreover, the results obtained in the previous chapter show that human capital and infrastructure play significant roles in determining the impact of openness measures on growth.

This chapter examines how openness to international trade influences growth of total factor productivity (TFP) by using panel data. Unlike cross-section data, panel data provide more information about individual countries over time, more degrees of freedom and a higher level of efficiency in empirical analyses. We begin our analysis by computing total factor productivity measures from a panel regression of output growth on the changes of labour and physical capital inputs. We then carry out various regressions of TFP on a range of trade and trade policy variables, while controlling for other TFP determinants. Our analysis is an extension of the empirical work of Edwards (1998) and Chapter 4 of this thesis. In this chapter, we approach our investigation by employing panel data (aimed to obtain more information on individual countries), dividing countries into three separate samples according to their level of per capita income (to capture the conditionality of the link between trade and growth) and dividing the study period into three sub-periods (to examine the size and significance of the impact of trade on growth in different time periods).

5.2 Summary Statistics

Data for two of openness measure used in the previous chapter (WDR and LEAMER) are not available over time. Therefore, they cannot be used in this chapter, as we are using panel data set. However, we added two other openness indicators that are widely used by other researchers: the ratio of trade (export + import) in GDP (TRADE) and a trade distortion indicator (DISTORT) measured as $(1 + t_m)/(1- t_x)$, where t_m and t_x represent duties on import and export, respectively. A summary of some basic trade indicators is presented in Table 5.1. As can be seen from the table, there has been a considerable degree of integration by the middle-income countries. Between 1970s and 1990s trade volume as a proportion of GDP has almost doubled from 31.9% to 58.4%. During the same period high-income countries trade has increased from 58.2% to 86.7%, while low-income countries experienced a fall in their trade volume in the 1980s before it slightly recovered in the 1990s.

The black market premium was considerably high in the 1980s in both middle- and low-income countries. In the 1990s both middle- and low-income countries managed to bring the premium to a level lower than the 1970s average. There has been a substantial reduction of tariff rates in the middle-income countries by a total of 23% between 1970 and 1999; while low-income countries have a rather modest tariff rate cut of 13%. Similar cuts have been taken with respect to collected taxes in international trade (CTR), that is, 29 percentage cut in middle-income countries and 15 % cut in low-income countries. Appendix 7 presents figures that show variations in openness measures across the countries at different period.

Table 5.1

Summary of trade policy variables

	1970-1979				1980-1989				1990-1999			
	TRADE	BMP	TARIFF	CTR	TRADE	BMP	TARIFF	CTR	TRADE	BLACK	TARIFF	CTR
High-income	58.2	0.084	5.5	6.1	75.8	0	3.2	3.5	86.7	0	1.5	1.4
Middle-income	31.9	45.5	54.3	62	53.2	100.2	63.7	69.2	58.4	40.4	31.2	33.6
Low-income	23.4	61.1	66.4	69.8	19.2	348.8	68.9	67	27.7	58.3	47.5	51.2

Note: TRADE denotes ratio of export + import in GDP, BMP is black premium, TARIFF is ratio of import duty to total import, CTR is ratio of collected tax on international trade to total revenue.

Correlation between Openness Measures

Table 5.2 presents simple correlation test results between five of our openness measures. Broadly, the results suggest that there is high negative correlation (-0.71) between TRADE and BMP. TRADE is also negatively correlated with TARIFF and CTR, with the values of -0.59 and -0.64, respectively. BMP, on the other hand, seems to be positively correlated with TARIFF and CTR. There is also high positive correlation between TARIFF and CTR. The general implication of these correlation figures is that TRADE is inversely related with BMP, TARIFF and CTR.

Table 5.2

Correlation test for five openness measures

	TRADE	*BMP*	*TARIFF*	*CTR*	*DISTORT*
TRADE	1				
BMP	-0.71	1			
TARIFF	-0.59	0.62	1		
CTR	-0.64	0.65	0.86	1	
DISTORT	-0.66	0.73	0.72	0.67	1

Source: Own calculation

Although these openness measures are correlated, lack of perfect correlation and in some cases different signs indicate that they are capturing different aspects of openness or trade policy. For example, TARIFF measures to what extent duties on imports affect the flow of goods that will be beneficial to higher productivity. Black, on the other hand, measures the extent to which inexpedient exchange rate policies may lead to trade distortions.

5.3 Regression Results

5.3.1 Estimates of the production function

The modelling strategy employed in this chapter is essentially an extension of the model used in Chapter 4. In this chapter we introduce several novel features in to the analysis to capture the link between factor productivity and a range of openness and trade policy variables. The specification is also extended to explore the impact of trade liberalisation on productivity in different time periods. As in Chapter 4, the TFP measures (Solow residuals) emanate from the panel regression of growth of real GDP (y) on the growth of labour (l) and physical capital (k) inputs and it takes the following form:

$$y_{it} = \alpha_i + \beta_i l_{it} + \gamma_i k_{it} + \lambda + \varsigma_t + \varepsilon_i + \mu_{it} \tag{5.1}$$

We embark on using a panel of 86 countries for the period 1970-1999[1]. We have attempted to include as many developing countries as we possibly can. Our data set includes 22 high-income, 34 middle-income and 30 low-income countries. The list of countries included in the regression is reported in Appendix 8.

The estimated production function is the following:

$$\hat{y} = \underset{(2.63)}{0.67}\,l + \underset{(3.09)}{0.28}\,k \qquad R^2 = 0.82 \qquad F = 26.9 \qquad (5.2)$$

$SEE = 0.131$

The estimated coefficients of growth of labour and capital show that these two inputs have significant contribution to the growth of the output.

TFP growth data gives mixed picture across different groups. In the case of low-income countries, it has declined from 2.8% per annum in the 1970s to 1.1% in the 1980s and then increased to only 1.6% in the 1990s. Middle-income countries experience an increase in the TFP growth from 2.6% to 3.7% in the 1980s and 5.2% in the 1990s. High-income countries, on the other hand, show a modest growth between 1970 and 1999.

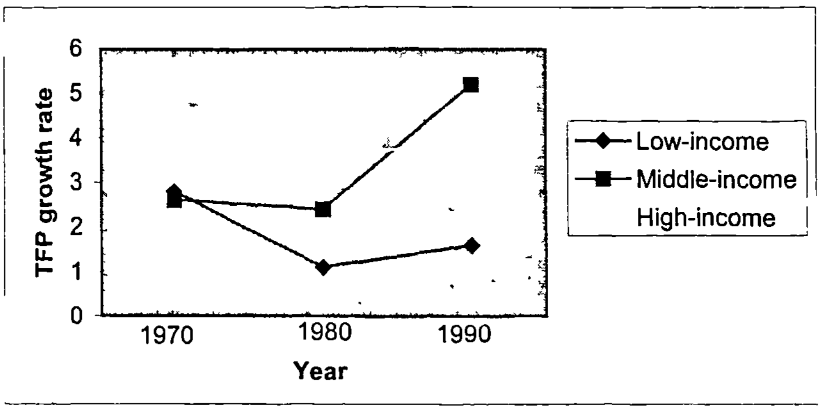
Taking a few countries for comparative purpose provides some suggestive evidence on whether openness indeed enhances growth. For example, Kenya with an average of trade 5% GDP, 35% tariff and 39% CTR experienced slower TFP growth (an average of 0.8% between 1970-1999) than Malaysia (which experienced 6.7% average growth of TFP) with comparative figures of 87% trade-GDP ratio, 15.2% tariff rate and 14% CTR rate; or Honduras with an average tariff rate of 58% and experienced a fall in its TFP growth by –1.3% compared to Costa Rica with an average TFP growth of 3.9% and tariff rate of 26%. Nevertheless, we need to be cautious in suggesting the universality of such results based on average or individual empirical analysis. It is implausible to suggest that such rally in growth is due to openness measures taken by the countries under question.

The other important point worth mentioning here is that human capital has increased substantially in the middle-income countries, from an average of 27% in 1970 to 34% in 1980s and to 52% in the 1990s, as compared to low-income countries, which has increased from an average of 13% 1970s to only

[1] Note here that all the growth data include 1969-1999.

22% in 1980s and 30% in the 1990s. It can also be seen there has been higher rate of TFP growth in the 1990s than the 1980s and 1970s (see Figure 5.1). In addition to trade policy, these countries have undertaken a number of policy reforms such as building infrastructure, reducing defence expenditure and increasing human capital. Moreover, we want to emphasise that developing countries have to concentrate on the factors that will determine their absorptive capacity to adapt new technologies developed abroad. We hypothesise that the absorptive capacity is determined by their level of development in terms of human capital endowment and quality of infrastructure. Opening up to international trade by itself cannot guarantee growth unless they have enough skilled labour that will enable them to adapt new ideas developed in the advanced nations.

Figure 5.1
TFP growth 1970-1999



5.3.2 Unit roots test results

The first step of our empirical work focuses on the analysis of the time series properties of the data. We carry out tests for non-stationarity for the variables included in each panel used to estimate TFP growth. Table 5.3 presents the results obtained by applying the unit root test technique proposed by Im, Pesaran and Shin (1998) (see Appendix 9 for details on IPS unit root test) for the log of TRADE, BMP, TARIFF, CTR, GOV, INF, XRATE, HK, and INFRA. The tests are performed both on levels and on first differences of the variables.

The IPS unit root test allows each component of the panel to have different autoregressive parameter and short-run dynamics under the alternative hypothesis of stationarity. The test, based on the mean of the statndard ADF test, is computed independently for each country allowing for up to five lags and simplifying the model when ever possible without inducing autocorrelation and heteroschedasticity. Under the null of non-stationarity the test is distributed as N(0,1), so that large negative numbers indicate in favour of stationarity.

Table 5.3

Unit Root test results

Variable	*Average ADF (levels)*	*Average ADF (First differences)*
TRADE	1.22	-6.94
BLACK	2.46	-5.68
TARIFF	-1.07	-10.22
CTR	-1.85	-8.46
GOV	-1.04	-7.93
DISTORT	-1.51	-8.38
XRATE	0.524	-8.26
INF	-1.27	-5.11
HK	-1.90	-6.42
INFRA	-1.65	-7.20

Note: Time trend included. Test statistic is N(0,1) under the null of non-stationarity. Large negative values indicate stationarity.

With respect to the full sample of countries, the results show that with the exception of human capital, in all variables we cannot reject a unit root for our variables in levels. For example, log GOV with 86 countries in the regression. We carried out 86 augmented Dickey-Fuller regression to find an average t-value of -1.04. Under the null of non-stationarity, the t-value in each country has an expected value of -1.97 with a variance of 0.8651 (as tabulated by IPS). Since the average t-value is less than the critical value we cannot reject a unit root for log GOV. In a similar analogue, it is clear we cannot reject a unit root for the remaining variables in levels.

In order to determine if the variables are I(1) we carried out a test for stationarity in first differences. The unit root test results show that in very case we reject a unit root in first differences at 5% significance level. Cointegration tests have also been carried out even though it is not essential given the fact that our estimated coefficients will be consistent whether or not we have a cointegrating relationship among our variables (Kao, 1997).

5.3.3 TFP regression results

In this section we discuss factors that affect the growth of total factor productivity. Total factor productivity is obtained as discussed in section 5.3.1 based on production function. The empirical specification of TFP regression is written as follows:

$$TFP_{it} = \beta_1 + \beta_2 \ln GDP70_{it} + \beta_3 \ln HK70_{it} + \beta_4 Z_{it} + \beta_5 X_{it} + \varepsilon_{it} \qquad (5.3)$$

where *GDP70* is the initial level of GDP per capita, *HK70* denotes the initial level of human capital, Z represents openness and trade liberalisation measures included in the regression, X represents the vector of controlling variables (such as government consumption, inflation, etc) and ε is the error term.

As indicated earlier, we have run a variety of regressions that included openness and trade liberalisation variables separately. The size of each sample

Table 5.4

Panel data regression for full sample of countries, 1970-1999

Dependent Variable: TFP growth
Fixed Effect Estimator

	1	2	3	4	5	6
ln GDP70	-0.002**	-0.003**	-0.003**	-0.004**	-0.005**	-0.004**
	(-2.34)	(-2.36)	(-2.37)	(-2.41)	(-2.44)	(-2.42)
ln HK70	0.002*	0.003*	0.002*	0.003*	0.003*	0.003*
	(2.26)	(2.29)	(2.26)	(2.29)	(2.30)	(2.29)
ln TRADE	0.22***					
	(4.10)					
SW		0.005**				
		(2.57)				
ln BMP			-0.03***			
			(-3.29)			
ln TARIFF				-0.004**		
				(-2.46)		
ln CTR					-0.01**	
					(-2.59)	
ln DISTORT						-0.002**
						(-2.41)
R^2	0.79	0.77	0.79	0.78	0.79	0.78
N	2580	2580	2580	2460	2460	2460
AR	0.0173	0.0119	0.0106	0.0127	0.0136	0.0116
HS	13.7	16.2	11.5	15.48	19.3	17.2

*Note: Figures in parentheses are heteroschedasticity consistent t-values. ln GDP70 and ln HK70 represent initial levels of income per capita and human capital. TRADE equals ratio of export + import in GDP, SW represents binary openness measures as defined by Sachs and Warner (1995), ln BMP denotes black premium, ln TARIFF is import duties, ln CTR is ratio of collected tax on international trade to total revenue, ln DISTORT is trade distortionay measure defined as $(1+t_m)/(1-t_x)$, where t_m and t_x denote duties on imports and exports, respectively. AR denotes the estimated autocorrelation coefficient, values ranging between -1 and 1. Values close to 0 indicate no autocorrelation problem. Figures in parentheses are t-values. *** , ** and * denote respectively the 1 percent, 5 percent and 10 percent level of significance*

depends on the country coverage of each openness indicators as well as the availability of data for human capital and infrastructure variables. Tables 5.4-5.13 present regression results with various specifications. In all regressions the Hausman's test suggest that fixed effects give better results than random effect technique. The diagnostic test statistics show no evidence of serial correlation, since all estimated autocorrelation test figures are close to zero. According to the White test, heteroschedasticity does not pose any problem in the regression results. All White test values are less than the critical value.

In all regressions initial level of GDP per capita hold the expected negative sign and in four out six regressions it is statistically significant. The estimated coefficient of initial level of income per capita is interpreted by a number of authors (see for example, Barro, 1991; Barro and Sala-I-Martin, 1995; Edwards, 1992; and Levin and Renelt, 1992) as a test of convergence hypothesis among countries in the regression. This is as predicted by the neoclassical growth models that growth rates tend to be inversely related to initial GDP per capita. Other interpretation has also been given by suggesting that it is a test of mean reversion, which is a necessary but not sufficient condition for convergence (Litchtenberg, 1994). Edwards (1992), on the other hand, suggested that this is an indication that countries with lower initial per capita income have greater chance of catching up with advanced nations. In all regressions after controlling for the initial level of human capital and openness variables, the estimated results for the initial level of per capita income indicate that there is significant conditional convergence in the TFP growth of sample countries. Nevertheless, the magnitude of the estimated coefficient provides evidence that the convergence process is considerably slow. The estimated coefficients for initial level of human capital are positive and statistically significant at conventional levels. This can be interpreted as that countries with good initial human capital stock do have greater advantage or ability to innovate or adopt foreign technology.

The regression results for the full sample countries (see Table 5.4) provide some evidence that open economies tend to benefit from a high volume of trade, lower black market premium, lower tariff rates and lower taxes on international trade. The openness variables, SW and TRADE, turned out to have strong and positive impact on growth. For example, the estimated coefficient of SW is 0.005 (which is significant at 5% level), implies that an economy open to trade during 1970-1999 (open=1 in a scale of 1.0) grew by 0.5 percentage points faster per year than an economy which is completely closed through out the period. BMP, TARIFF, CTR and DISTORT also hold the expected negative coefficients, which are statistically significant at conventional levels. For example, a 1% tariff cut would induce a 0.004% TFP growth. Broadly, the results show that trade distortive measures have a detrimental effect on growth.

To investigate the degree of the impact of openness and trade liberalisation at different period, we divided the sample period into three sub-periods (1970-1979, 1980-1989 and 1990-1999). Table 5.5 presents regression results for each decade. The results are more or else consistent with respect to the positive association of openness to growth. However, a closer observation of the estimated coefficients and significance levels of the openness measures suggest that the impact of openness variables is continually increasing from one decade to another.

The regression results for the three sub-periods indicate that there is consistent convergence among sample countries. However, in the regression for the period 1970-1979 the estimated coefficient for GDP70 is only statistically significant in four regressions out of six (at 10% level in all cases). It can also be seen that the size of the estimated coefficient is very low in the 1970s compared to the 1980s and 1990s regression results. Although the magnitude of this variable seems to have increased in most cases of the regression results for the 1980s compared to the 1970s results, it is only statistically significant at 10% level in all regressions. In the regression for the 1990s the coefficient of GDP70 is statistically significant in all regressions with a larger size as compared to that in the regression results for the preceding two decades. The general interpretation of these results is that although there has been some sign of convergence taking place in the 1970s and 1980s significant conditional convergence has only been observed in the 1990s. Moreover, considering the size of the estimated coefficients for this variable, it can be suggested that the convergence among sample countries even in the 1990s is too slow. With respect to HK70 it can be seen that, in general, its

Table 5.5
Total Factor Productivity Regression at Different Period

	1970-1979						*1980-1989*						*1990-1999*					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
lnGDP70	- 0.0002 (-2.03)	-0.0001 (-1.97)	-0.0001 (-1.98)	-0.0003 (-2.07)	-0.0003 (-2.06)	- 0.0002 (-2.04)	-0.001 (-2.41)	-0.001 (-2.41)	-0.001 (-2.40)	-0.002 (-2.44)	-0.002 (-2.44)	-0.002 (-2.43)	-0.003 (-2.16)	-0.003 (-2.17)	-0.002 (-2.13)	-0.003 (-2.20)	0.003 (-2.19)	-0.002 (-2.17)
ln HK70	0.004 (2.63)	0.004 (2.60)	0.004 (2.61)	0.005 (2.67)	0.005 (2.65)	0.004 (2.63)	0.002 (2.47)	0.002 (2.45)	0.002 (2.47)	0 002 (2.47)	0.003 (2.48)	0.002 (2.47)	0.002 (2.58)	0.003 (2.60)	0.002 (2.57)	0.003 (2.63)	0.003 (2.63)	0.003 (2.61)
ln TRADE	0.11 (2.69)						0.19 (2.93)						0.25 (4.67)					
SW		0.002 (2.18)						0.003 (2.30)						0.005 (2.78)				
ln BMP			-0.02 (-2.71)						-0.01 (-2.87)						-0.05 (-3.21)			
ln TARIFF				-0.003 (-2.14)						-0.005 (-2.40)						-0.009 (-2.59)		
Ln CTR					-0.005 (-2.25)						-0.007 (-2.46)						-0.05 (2.64)	
ln IDISTORT						-0.001 (-2.43)						-0.004 (-1.85)						-0.003 (-2.76)
R^2	0.54	0.53	0.53	0.51	0.52	0.51	0.63	0.64	0.62	0.60	061	0.60	0.87	0.88	0.87	0.85	0.86	0.85
N	860	860	860	820	820	820	860	860	860	820	820	820	860	820	860	820	820	820
AR	0.0091	0.0076	0.0071	0.0087	0.0098	0.0074	0.0091	0.0080	0.0093	0.0084	0.0088	0.0096	0.0079	0.0085	0.0097	0.0072	0.0087	0.0085
HS	11.5	9.27	11.20	9.59	10.37	11.08	10.57	10.12	11.29	10.31	10.27	10.13	10.22	9.86	10.18	10.26	10.16	10.02

Note: Figures in parentheses are heteroschedasticity corrected t-ratio (White, 1981). Ln GDP70 and ln HK70 are initial levels of income per capita and human capital. Trade is ratio of exports and imports in GDP. SW denotes binary openness measure as defined by Sachs and Warner (1995).BLACK is black market premimium. TARIFF is import duty. CTR is collected tax on trade. DISTORT is measure of trade distortion (i.e. $1+t_m$) ($1-t_x$), where t_m and t_x are duties on imports and exports, respectively. AR denote the estimated autocorrelation coefficientt. Values close to 0 indicate no autocorrelation problem. Due to space restriction we can not report significance levels in this table.

contribution to TFP growth is higher in the 1970s than in the 1990s and 1980s. This seems to suggest that the 1970s stock of human capital is less compatible to the technological level of the 1980s or 1990s.

The results of different periods reveal that, in general, there are considerable differences in the magnitude and significance levels of the estimated coefficients of openness and trade policy variables. In the 1970s, for example, the impact of TRADE is that a 1% increase would lead TFP growth by 0.11%. The comparative figures for the 1980s and 1990s are 0.19% and 0.25%, respectively. On the other hand, if the tariff could be reduced by 1%, TFP would have grown by only 0.003% in the 1970s, whereas in the 1980s and 1990s the effect would be 0.005% and 0.009%, respectively. This implies that as countries improve their absorptive capacity with a better level of stock of human capital and quality of infrastructure, they tend to benefit more from openness.

5.3.4 Differences due to the level of development

The disaggregation of countries into groups of similar stages of development reveal some important results which are different from the regression results for the full sample. Table 5.6 presents the regression results of TFP growth for various groups of countries. The results provide several interesting points that are worth discussing. With respect to high-income countries the initial level of income per capita holds the expected negative sign in all regressions and it is statistically significant at conventional level (mainly at 1% level). The size of the estimated coefficients are also much higher compared to the full sample regression results as well as in the case of middle-income and low-income countries. For example, in regression 1 of Table 5.6 the estimated coefficient of GDP70 for high-income countries is -0.03. Comparative figures for middle- and low-income countries are -0.004 and -0.0006, respectively. Besides the low magnitude of these coefficients, in the case of low-income countries none of the coefficients of GDP70 are statistically significant, while it is significant at 1% level for high-income countries and at 10% level for middle-income countries. In the case of low-income countries none of the estimated coefficients of GDP70 are statistically significant, although they all hold the right sign. The overall feature of the estimated results for initial income per capita is that during 1970-1999 convergence has taken place at large among high-income countries. In the low-income countries, on the other hand, the results exhibit that there was no significant convergence among these countries after accounting for initial level of human capital and openness measures. In contrast to the full sample results the estimated coefficient of the initial level of per capita income indicates that there is significant and relatively fast convergence process among high-income countries.

Initial level of human capital holds the positive sign in all regressions. However, the results show that its effect is much higher in the high-income countries than middle- and low-income countries. Moreover, although the estimated coefficient of HK70 is positive in all regressions for low-income countries, none of them are statistically significant. This indicates that the contribution of initial level of human capital to TFP growth is very low in low-income countries. It is also clear that its contribution in the middle-income countries is not as powerful as it is in the case of high-income countries, as its size is smaller. The initial level of human capital seems to suggest that high-income countries have a relatively large stock of human capital which enables them to grow faster either through innovation or imitation of new technology.

With respect to high-income countries all trade related variables hold the expected signs and they are highly significant. TRADE and SW have positive coefficients, which are statistically significant at 1% level. The estimated coefficients of TARIFF, CTR and DISTORT hold negative signs and they are statistically significant. Moreover, the size of the estimated coefficients of these

Table 5.6
Total Factor Productivity Regression for different groups of countries
Fixed effect estimator (1970-1999)

	High-income					*Middle-income*						*Low-income*					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
lnGDP70	-0.03 (-2.79)	-0.02 (-2.77)	-0.02 (-2.77)	-0.03 (-2.80)	-0.03 (-2.81)	-0.004 (-2.24)	-0.003 (-2.22)	-0.003 (-2.19)	-0.005 (-2.27)	-0.005 (-2.28)	-0.005 (-2.27)	-0.0006 (-1.85)	-0.0006 (-1.83)	-0.0006 (-1.80)	-0.0007 (-1.86)	-0.0007 (-1.88)	-0.0006 (-1.85)
ln HK70	0.05 (3.27)	0.05 (3.27)	0.05 (3.25)	0.05 (3.27)	0.04 (3.23)	0.006 (2.40)	0.006 (2.41)	0.005 (2.37)	0.007 (2.44)	0.007 (2.45)	0.007 (2.45)	0.001 (1.94)	0.001 (1.94)	0.001 (1.93)	0.001 (1.95)	0.002 (1.95)	0.002 (1.96)
ln TRADE	0.28 (5.12)					0.15 (2.84)						0.06 (1.71)					
SW		0.02 (2.91)					0.004 (2.15)						0.001 (1.52)				
ln BMP								-0.06 (-3.19)						-0.03 (-2.85)			
ln TARIFF	.		-0.05 (-2.62)						-0.003 (-2.26)						0.005 (2.37)		
Ln CTR				-0.09 (-2.86)						-0.007 (-2.49)						0.001 (2.14)	
ln IDISTORT					-0.03 (-2.64)						-0.005 (-2.37)						0.002 (1.92)
R^2	0.73	0.75	0.72	0.72	0.71	0.83	0.82	0.83	0.85	0.85	0.84	0.69	0.69	0.68	0.67	0.67	0.67
N	660	660	660	660	660	1020	1020	1020	960	960	960	900	900	900	840	840	840
AR	0.0063	0.0071	0.69	0.0061	0.0083	0.0075	0.186	0.0131	0.0109	0.0117	0.0097	0.0106	0.0113	0.0129	0.0181	0.0170	0.0177
HS	3.71	2.97	3.16	3.39	3.46	2.78	3.27	2.48	2.63	2.71	3.19	3.06	2.89	2.77	3.01	3.18	2.84

Note: Figures in parentheses are heteroschedasticity corrected t-ratio (White, 1981). Ln GDP70 and ln HK70 are initial levels of income per capita and human capital. Trade is ratio of exports and imports in GDP. SW denotes binary openness measure as defined by Sachs and Warner (1995).BLACK is black market premimium. TARIFF is import duty. CTR is collected tax on trade. DISTORT is measure of trade distortion (i.e. $1+t_m$) ($1-t_x$), where t_m and t_x are duties on imports and exports, respectively. AR denotes the estimated autocorrelation coefficient. Values close to 0 indicate no autocorrelation problem. Due to space restriction we can not report significance levels in this table.

Variables are relatively larger compared to the full sample regression results as well as results for middle- and low-income countries. In the case of middle-income countries, the results show that openness measures hold the expected signs and they all are statistically significant. Nevertheless, their effect seems to be much smaller as compared to high-income countries. For example, in the case of high-income countries, 1% increase in TRADE may induce TFP growth by 0.28%, whereas in the middle-income countries the effect will only be 0.15%. This can be considered as the effect of openness is different for countries with different levels of development.

More compelling results have emerged for low-income countries. The estimated coefficients of trade related variables provide a different picture than we have observed for the rest of income groups. As can be seen from Table 5.6 the estimated results show that there is no significant association between TRADE and TFP growth, although it holds positive coefficient. More interestingly, as in the case of the previous chapter the estimated results indicate that TARIFF and CTR have significant positive contribution to TFP growth. Both TARIFF and CTR are statistically significant at 10% level. The results imply that a 1% increase in TARIFF and CTR would stimulate TFP growth by 0.005% and 0.001%, respectively. These results are consistent with what we found in Chapter 4 using cross-section regression. As we noted there, the positive contribution of TARIFF and CTR in low-income countries came about through their effect on revenue and hence to investment or there was the possibility that protection for infant industries was working for low-income countries (this will be tested at a later stage). DISTORT also seems to be positively associated with TFP growth among the low-income countries, although it is not statistically significant. BMP, on the other hand, holds the expected sign, which is statistically significant at 1% level, reaffirming its adverse effect to TFP growth.

5.3.5 Impact of openness at different periods in different groups of countries

Tables 5.7-5.9 present regression results for high-, middle- and low-income countries at three different sub-periods, 1970-1979, 1980-1989 and 1990-1999. All the diagnostic tests show that the model is a good fit and efficient to explain TFP growth. The results show that in the 1970s it is only high-income countries that seem to have benefited more from openness. Only in high-income countries TRADE-TFP growth relationship show statistically significance (at 1% level). Indeed, it holds negative coefficient for low-income countries, though not statistically significant. With respect to middle-income countries the positive association of TRADE and TFP growth is not statistically significant. In the regressions for 1970-1979, Sachs-Warner (SW) openness measure maintains its positive sign in all three income groups, but it is only significant in the case of high-income countries at 5% level.

In the 1970s the negative impact of TARIFF seems to be confined to high-income countries, as the estimated value for middle-income countries failed to be significant and in the case of low-income countries it is positive and significant at 5% level. During the same period (1970s), the results show that CTR has a significant adverse effect on TFP growth in both high- and middle-income countries, while it exhibits significant positive effect in the low-income countries. DISTORT also seems to have negative impact on TFP growth in the high- and middle-income countries. With respect to low-income countries DISTORT seems to have positive impact on TFP, though not statistically significant.

The regression results for the 1980s show that there has been significant convergence among sample countries. However, although GDP70 holds a negative coefficient in the regressions for low-income countries, it is not statistically significant at conventional levels. In the case of middle-income countries the regression provides evidence of significant convergence in these

Table 5.7
Total Factor Productivity Regression for high-income countries
Fixed effect estimator (1970-1999)

	1970-1979					*1980-1989*					*1990-1999*				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
lnGDP70	-0.006 (-2.46)	-0.004 (-2.43)	-0.006 (-2.47)	-0.006 (-2.47)	-0.005 (-2.45)	-0.01 (-2.71)	-0.02 (-2.76)	-0.02 (-2.76)	-0.03 (-2.79)	-0.02 (-2.77)	-0.05 (-3.16)	-0.05 (-3.17)	-0.05 (-3.17)	-0.06 (-3.20)	-0.05 (-2.18)
ln HK70	0.03 (2.79)	0.03 (2.79)	0.03 (2.77)	0.02 (2.73)	0.02 (2.74)	0.01 (2.36)	0.02 (2.39)	0.01 (2.37)	0.01 (2.39)	0.01 (2.36)	0.004 (2.51)	0.004 (2.51)	0.004 (2.48)	0.003 (2.44)	0.003 (2.45)
ln TRADE	0.15 (2.97)					0.21 (3.17)					0.33 (6.42)				
SW		0.004 (2.26)					0.007 (2.49)					0.04 (2.17)			
ln BMP															
ln TARIFF			-0.006 (-2.39)					-0.02 (-3.09)					-0.08 (-2.89)		
Ln CTR				-0.02 (-2.56)					-0.03 (-2.73)					-0.09 (-3.15)	
ln DISTORT					-0.004 (-2.51)					-0.007 (-2.67)					-0.05 (-2.81)
R^2	0.54	0.55	0.54	0.55	0.55	0.72	0.71	0.71	0.72	0.71	0.86	0.86	0.86	0.85	0.85
N	660	660	660	660	660	660	660	660	660	660	660	660	660	660	660
AR	0.0093	0.0087	0.072	0.077	0.0080	0.0099	0.0079	0.0092	0.0091	0.0084	0.0088	0.0101	0.0109	0.092	0.097
HS	2.16	2.37	1.96	1.98	2.07	2.19	2.20	2.13	1.97	2.17	2.08	1.93	1.99	2.10	2.08

Note: Figures in parentheses are heteroschedasticity corrected t-ratio (White, 1981). Ln GDP70 and ln HK70 are initial levels of income per capita and human capital. Trade is ratio of exports and imports in GDP. SW denotes binary openness measure as defined by Sachs and Warner (1995).BLACK is black market premimium. TARIFF is import duty. CTR is collected tax on trade. DISTORT is measure of trade distortion (i.e. $1+t_m$) $(1-t_x)$, where t_m and t_x are duties on imports and exports, respectively. AR denote the estimated autocorrelation. Values close to 0 indicate no autocorrelation problem. Due to space restriction we can not report significance levels in this table.

Table 5.8
Total Factor Productivity Regression for middle-income countries
Fixed effect estimator (1970-1999)

	1970-1979						*1980-1989*						*1990-1999*					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
lnGDP70	-0.001 (-2.13)	-0.002 (-2.16)	-0.001 (-2.14)	-0.002 (-2.19)	-0.003 (-2.20)	-0.003 (-2.19)	-0.006 (-2.41)	-0.006 (-2.40)	-0.005 (-2.39)	-0.006 (-2.41)	-0.007 (-2.43)	-0.007 (-2.43)	-0.01 (-2.72)	-0.01 (-2.71)	-0.009 (-2.67)	-0.02 (-2.73)	-0.01 (-2.72)	-0.02 (-2.74)
ln HK70	0.007 (2.46)	0.006 (2.44)	0.006 (2.45)	0.006 (2.44)	0.007 (2.47)	0.007 (2.46)	0.002 (2.31)	0.002 (2.30)	0.001 (2.27)	0.002 (2.31)	0.002 (2.32	0.001 (2.31)	0.003 (2.11)	0.003 (2.13)	0.003 (2.10)	0.002 (2.08)	0.003 (2.11)	0.003 (2.12)
ln TRADE	0.06 (1.88)						0.11 (2.57)						0.18 (3.27)					
SW		0.001 (1.95)						0.007 (1.82)						0.008 (2.31)				
ln BMP			-0.09 (-3.28)						-0.05 (2.78)						-0.02 (-2.83)			
ln TARIFF				-0.001 (-1.79)						-0.004 (-2.12)						-0.005 (-2.47)		
Ln CTR					-0.002 (-2.17)						-0.005 (-2.26)						-0.01 (-3.60)	
ln distort						-0.002 (-2.28)						-0.007 (-2.16)						-0.02 (-2.53)
R^2	0.45	0.45	0.45	0.45	0.46	0.45	0.76	0.76	0.76	0.75	0.77	0.77	0.72	0.71	0.71	0.70	0.71	0.71
N	1020	1020	1020	960	960	960	1020	1020	1020	960	960	960	1020	1020	1020	960	960	960
AR	0.0106	0.0110	0.099	0.0102	0.0119	0.0110	0.0105	0.0117	0.0112	0.0108	0.0114	0.105	0.0092	0.0097	0.0107	0.0111	0.0116	0.0113
HS	2.37	2.44	2.40	2.31	2.19	2.34	2.63	2.61	2.78	2.66	2.80	2.64	2.27	2.30	2.34	2.21	2.16	2.17

Note: Figures in parentheses are heteroschedasticity corrected t-ratio (White, 1981). Ln GDP70 and ln HK70 are initial levels of income per capita and human capital. Trade is ratio of exports and imports in GDP. SW denotes binary openness measure as defined by Sachs and Warner (1995).BLACK is black market premimium. TARIFF is import duty. CTR is collected tax on trade. DISTORT is measure of trade distortion (i.e. $1+t_m$) ($1-t_x$), where t_m and t_x are duties on imports and exports, respectively. AR denote the estimated autocorrelation. Values close to 0 indicate no autocorrelation problem. Due to space restriction we can not report significance levels in this table.

Table 5.9
Total Factor Productivity regression for low-income countries
Fixed effect estimator (1970-1999)

	1970-1979						*1980-1989*						*1990-1999*					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
lnGDP70	-0.0002 (-1.50)	-0.0002 (-153)	-0.0002 (-1.51)	-0.0003 (-1.56)	- 0.0003 (-1.54)	- 0.0003 (-1.55)	0.0008 (-1.73)	-0.0007 (-1.72)	-0.0007 (-1.69)	-0.0008 (-1.74)	-0.0008 (-1.73)	-0.0007 (-1.73)	-0.003 (-2.17)	-0.003 (-2.19)	-0.002 (-2.11)	-0.004 (-2.21	-0.004 (-2.20)	-0.003 (-2.19)
ln HK70	0.0005 (1.72)	0.0005 (1.72)	0.0006 (1.77)	0.0005 (1.73)	0.0006 (1.76)	0.0006 (1.75)	0.001 (1.53)	0.001 (1.53)	0.001 (1.54)	0.001 (1.57)	0.001 (1.51)	0.001 (1.53)	0.007 (1.87)	0.007 (1.88)	0.006 (1.85)	0.006 (1.88)	0.006 (1.87)	0.006 (1.85)
ln TRADE	-0.0013 (-0.769)						0.002 (1.19)						0.09 (1.84)					
SW		0.0003 (1.16)						0.0005 (1.37)						0.003 (1.75)				
ln BMP			-0.03 (-2.58)						-0.03 (-2.74)						-0.07 (2.94)			
ln TARIFF				0.007 (2.61)						0.0004 (2.48)						0.007 (2.15)		
Ln CTR					0.004 (2.52)						0.002 (2.26)						0.001 (2.05)	
ln distort						0.005 (2.27)						0.003 (1.86)						0.001 (1.94)
R^2	0.39	0.38	0.39	0.40	0.39	0.39	0.53	0.53	0.54	0.54	0.52	0.52	0.75	0.75	0.75	0.75	0.75	0.76
N	900	900	900	840	840	840	900	900	900	840	840	840	900	900	900	840	840	840
AR·	0.0105	0.0102	0.0099	0.0093	0.0095	0.0100	0.0087	0.0082	0.0094	0.0090	0.0082	0.0093	0.0117	0.0110	0.0106	0.0114	0.0112	0.0111
HS	2.38	2.27	2.30	2.32	2.39	2.31	2.46	2.33	2.40	2.37	2.31	2.36	2.27	2.25	2.21	2.19	2.30	2.36

Note: Figures in parentheses are heteroschedasticity corrected t-ratio (White, 1981). Ln GDP70 and ln HK70 are initial levels of income per capita and human capital. Trade is ratio of exports and imports in GDP. SW denotes binary openness measure as defined by Sachs and Warner (1995).BLACK is black market premimium. TARIFF is import duty. CTR is collected tax on trade. DISTORT is measure of trade distortion (i.e. $1+t_m$) ($1-t_x$), where t_m and t_x are duties on imports and exports, respectively. AR denote the estimated autocorrelation. Values close to 0 indicate no autocorrelation problem. Due to space restriction we can not report significance levels in this table.

countries. It is, however, clear that the convergence is more pronounced in the high-income countries.

In all regressions HK70 holds the expected positive sign, although it is not statistically significant in the case of low-income countries. The main feature of these results is that countries (like low-income countries) with weak education facilities and low human capital stock seem to have difficulties in absorbing new technologies.

The regressions for openness measures provide consistent and credible results in all income groups. The estimated coefficient of TRADE, which is negative in the regression for the 1970s for low-income countries, becomes positive for the 1980s, though not statistically significant. In the case of middle-income countries TRADE does not have a significant effect on growth during the 1970s, while in the 1980s its effect becomes statistically significant at 5% level. With respect to high-income countries, in additional to their higher significance level, the magnitude of the openness measures is much higher in the 1980s than it was in the 1970s. This trend has also been observed in the regression results for 1990s. The results show that TARIFF, CTR and DISTORT are positively associated with growth in low-income countries. This effect seems to be higher in the 1980s than 1990s and 1970s. With respect to high-income countries the impact of TARIFF, CTR and DISTORT seems to be greater in the 1990s than the 1980s and 1970s. TRADE and SW, on the other hand, seem to follow upward trending effect between 1970s and 1990s.

In the case of low-income countries BMP is the only openness measure that holds the expected negative sign consistently with a significant impact on TFP growth. TARIFF, CTR and DISTORT, on the other hand, seem to have positive contribution to growth in all decades, although the effect is relatively smaller in the 1990s. In general, the regression results presented in Tables 5.7-5.9 show that the contribution of openness is strongly influenced by a country's level of development. In the earlier periods (1970s and 1980s) in LDCs, particularly in low-income countries, openness seems to have no significant positive effect on growth. Comparing the regression results of different income groups and the greater positive contribution of openness in the 1980s as compared to that in the 1970s and also the same of 1990s compared to those in the 1980s, suggest that countries need to go through a development process both technologically and in terms of human capital endowment to benefit from trade liberalisation.

5.3.6 The interaction effect between openness measures and level of development indicators

In the previous sections we have seen that there is a strong relationship between openness measures and economic growth in the high- and middle-income countries. With respect to low-income countries the results do not support the outward-orientation hypothesis. As we have obtained some evidence that openness is primarily associated with growth in countries that are well endowed with a stock of human capital and a reasonably good infrastructure that will enable them to effectively adopt new technology. Based on this argument we include an interactive term between openness measures and human capital as an explanatory variable. In such an alternative specification of the model we expect openness to be associated with higher rate of productivity growth and higher returns to human capital and also better quality of infrastructure. In other words, the positive effect of openness is effectual for countries with high level of human capital and infrastructure quality.

To investigate the effect of human capital and infrastructure (which we assume determine the absorptive capacity of a country), we have carried out various regressions that incorporate interaction terms between openness

Testing for interaction between openness and level of development indicators
Dependent Variable: TFP growth. Fixed effect estimator (1970-1999)

	High-income				*Middle-income*					*Low-income*				
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*
lnGDP70	-0.02 (-2.65)	-0.03 (-2.64)	-0.02 (-2.60)	-0.02 (-2.61)	-0.002 (-2.03)	-0.002 (-2.03)	-0.002 (-2.05)	-0.003 (-2.07)	-0.003 (-2.08)	-0.0003 (-1.81)	-0.0004 (-1.82)	-0.0005 (-1.84)	-0.0004 (-1.85)	-0.0003 (-1.82)
ln HK70	0.04 (3.09)	0.01 (3.11)	0.01 (3.10)	0.01 (3.13)	0.004 (2.15)	0.004 (2.13)	0.004 (2.14)	0.003 (2.11)	0.003 (2.10)	0.001 (1.85)	0.001 (1.84)	0.002 (1.89)	0.001 (1.85)	0.001 (1.85)
ln TRADE	0.21 (3 82)				0.10 (2.69)					0.04 (1.63)				
ln BMP						-0.04 (-2.93)					-0.02 (-2.79)			
ln TARIFF		-0.02 (-2.46)					-0.001 (-2.25)					0.002 (2.09)		
Ln CTR			-0.06 (-2.62)					-0.005 (-2.40)					0.0005 (1.98)	
ln DISTORT				-0.01 (-2.56)					-0.003 (2.29)					0.001 (1.80)
*ln TRADE**ln HK*ln INFRA*	0.14 (2.70)				0.08 (2.37)					0.07 (1.92)				
*ln BLACK**lHK*ln INFRA*						-0.05 (-2.97)					-0.006 (-2.45)			
*ln TARIFF*lnHK*ln INFRA*		-0.006 (-2.31)					-0.001 (-2.14)					-0.009 (-2.27)		
*ln CTR*ln HK*lnINFRA*			-0.01 (-2.49)					-0.003 (-2.35)					-0.007 (-1.83)	
*ln DISTORT*lnHK*ln INFRA*				-0.002 (--2.27)					-0.004 (-2.19)					-0.003 (-1.98)
ln HK	0.05 (2.61)	0.04 (2.57)	0.04 (2.55)	0.05 (2.62)	0.07 (2.70)	0.07 (2.68)	0.05 (2.61)	0.06 (2.64)	0.07 (2.70)	0.01 (2.39)	0.02 (2.43)	0.009 (3.30)	0.009 (2.31)	0.01 (2.37)
ln INFRA	0.02 (2.49)	0.02 (2.47)	0.01 (2.43)	0.02 (2.47)	0.01 (2.39)	0.01 (2.33)	0.009 (2.28)	0.009 (2.27)	0.009 (2.28)	0.006 (2.13)	0.006 (2.11)	0.005 (2.08)	0.006 (2.12)	0.006 (2.13)
R^2	0.79	0.79	0.79	0.80	0.86	0.87	0.87	0.88	0.87	0.68	0.69	0.69	0.69	0.68
N	660	660	660	660	1020	1020	960	960	960	900	900	840	840	840
AR	0.0117	0.0102	0.0128	0.0119	0.0165	0.0179	0.0153	0.0190	0.0142	0.0176	0.0161	0.0165	0.0182	0.0170
HS	6.19	5.80	5.93	6.10	4.92	4.63	5.01	4.83	4.79	6.67	6.15	5.78	6.55	6.47

Note: Figures in parentheses are heteroschedasticity corrected t-ratio (White, 1981). Ln GDP70 and ln HK70 are initial levels of income per capita and human capital. Trade is ratio of exports and imports in GDP. SW denotes binary openness measure as defined by Sachs and Warner (1995).BLACK is black market premimium. TARIFF is import duty. CTR is collected tax on trade. DISTORT is measure of trade distortion (i.e. $1+t_m$) $(1-t_x)$, where t_m and t_x are duties on imports and exports, respectively. AR denote the estimated autocorrelation coefficient. Values close to 0 indicate no autocorrelation problem. Due to space restriction we can not report significance levels in this table.

measures and human capital and infrastructure. Table 5.10 presents regression results that include the interaction terms. The regression results provide that human capital does indeed play significant role in determining the absorptive capacity of developing countries. The interactive term between HK, INFRA and TRADE is positive in all regressions implying that higher degree of openness as proxied by TRADE is positively associated with higher level of human capital.

In the case of high- and middle-income countries the interaction term between HK, INFRA and TRADE is positive and statistically significant, whereas in the case of low-income countries it is positive but not significant at conventional level. This seems to suggest that low-income countries have not reached the minimum level of stock of human capital and quality of infrastructure required for openness to be effective. Taken altogether, the results can be interpreted as openness can only have significant effect in the process of growth once countries acquire certain level of human capital stock.

The interaction term between HK, INFRA and BMP is negative in both regressions for middle- and low-income countries. This seems to suggest that greater openness raises the return to human capital. The interaction term between the level of development indicators (HK and INFRA) and TARIFF, CTR and DISTORT have negative coefficients in all regressions. With respect to high- and middle-income countries all three interaction term variables are significant at conventional levels, with higher effect in the middle-income countries. In the low-income countries, only the interaction between HK, INFRA and DISTORT is statistically significant at 10% level. The implication is that countries that are relatively well endowed with human capital and quality of infrastructure may experience significant positive impact on TFP growth from lower duties on trade, since they will have ability to absorb new technologies developed elsewhere. On the other hand, in countries that lack enough human capital stock and possess poor quality of infrastructure, lowering duties on trade may not generate high rate of growth.

We have carried out similar regressions by using interaction terms between human capital and openness measures, and infrastructure with openness indicators. The results are fairly similar and they are presented in Appendix 10.

5.3.7 Further regression analysis with control variables

With the exception of a few, (Edwards, 1992; Levine and Renelt, 1992; Harrison, 1996) most of the earlier studies have ignored controlling for other growth determinants in their regression analyses. Prudent macroeconomic policies usually create good economic environments for appropriate trade policies to be effective. If this is the case, omitting such factors in the regression analysis may lead to erroneously interpreting the impact of openness and ignoring actual consequences. For example, when Levine and Renelt (1992) include government expenditure in their regression the positive contribution of ratio of trade in GDP disappeared.

In this section we include five additional variables to carry out sensitivity testing: ratio of government consumption in GDP, rate of inflation, exchange rate, assassination and revolution. Furthermore, we examine the effect of openness by including human capital and infrastructure variables. Tables 5.12 and 5.13 present regression results that incorporate proxies for macroeconomic stability, political instability, human capital and infrastructure.

We began the regression by excluding human capital and infrastructure variables to investigate their impact when they are included. The regression results show that, with the exception of TRADE, the coefficients as well as the t-ratio of the rest of openness measures have not been changed significantly. It is, however, notable that the change in both the size and significance level of TRADE is very high in the case of middle-income countries. Without these variables TRADE is significant at 1% level (see Table 5.6). On the other hand, when we control for macroeconomic and political instability variables it becomes significant only at 10% level. This is, in some way, similar to the results obtained by Levine and Renelt (1992) and Harrison (1996), where the significant effect of trade variables disappears when macroeconomic variables are included. In the case of low-income countries although the t-value has changed, its effect is negligible as in either case it is not statistically significant. Interpreting these results is not straightforward. On the one hand, it is only TRADE that seems to be slightly fragile to the inclusion of macroeconomic and political instability variables. On the other hand, this sensitivity is more pronounced in the regression for middle-income countries. One interpretation for this would be TRADE might reflect other activities in the economy that could possibly be linked to the macroeconomic variables included in the regression. The other interpretation is that although the partial correlation matrix shows none of these variables are highly correlated with TRADE, it appears that there is some multicollinearity among the explanatory variables making it difficult to disentangle the partial impact of each of these variables. However, in general, we consider our results are robust at least to the inclusion of these variables.

Table 5.12 presents regression results that includes human capital and infrastructure. When human capital and infrastructure are added the size and the significance levels of trade related variables, in particular, have improved in most regressions. More interestingly, in the case of middle- and low-income countries the changes are higher. For example, in the case of middle-income countries TRADE is only significant at 10% level when we are holding for macroeconomic and political instability variables. When human capital and infrastructure are included it becomes significant at 5% level with higher

Further regression results with control variables (without human capital and infrastructure variables)
Dependent Variable: TFP growth. Fixed effect estimator (1970-1999)

	High-income					*Middle-income*						*Low-income*					
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*
lnGDP70	-0.01 (-2.79)	-0.01 (-2.80)	-0.01 (-2.80)	-0.01 (-2.82)	-0.01 (-2.80)	-0.004 (-2.19)	-0.003 (-2.15)	-0.003 (-2.18)	-0.005 (-2.22)	-0.005 (-2.21)	-0.004 (-2.19)	-0.0002 (-1.89)	-0.0003 (-1.91)	-0.0002 (-1.89)	-0.0004 (-1.93)	-0.0003 (-1.93)	-0.0003 (-1.92)
ln HK70	0.03 (3.14)	0.03 (3.17)	0.03 (3.15)	0.03 (3.17)	0.03 (3.16)	0.007 (2.24)	0.007 (2.24)	0.007 (2.26)	0.007 (2.29)	0.007 (2.27)	0.007 (2.28)	0.002 (1.89)	0.002 (1.91)	0.003 (1.94)	0.002 (1.91)	0.002 (1.91)	0.003 (1.94)
ln TRADE	0.26 (4.03)					0.08 (2.49)						0.05 (1.65)					
SW		0 01 (2.74)					0.004 (2.16)						0.0007 (1.63)				
ln BMP								-0.05 (-3.16)						-0.03 (-2.86)			
ln TARIFF			-0.03 (-2.60)						-0.004 (-2.37)						0.004 (2.30)		
Ln CTR				-0.09 (-2.88)						-0.006 (-2.45)						0.002 (2.08)	
Ln DISTORT					-0.05 (-2.73)						-0.003 (-2.41)						0.001 (1.87)
ln GOV	-0.08 (-2.62)	-0.07 (-2.65)	-0.09 (-2.65)	-0.08 (-2.61)	-0.08 (-2.61)	-0.12 (-2.78)	-0.13 (-2.83)	-0.13 (-3.85)	-0.12 (-2.79)	-0.13 (-2.82)	-0.13 (-2.80)	-0.17 (-2.91)	-0.18 (-2.93)	-0.18 (-2.93)	-0.17 (-2.92)	-0.17 (-2.91)	0.18 (2.94)
ln INF	-0.002 (-2.44)	-0.002 (-2.44)	-0.002 (-2.46)	-0.002 (-2.40)	-0.002 (-2.46)	-0.09 (-2.93)	-0.08 (-2.90)	-0 08 (-2.90)	-0.08 (-2.92)	-0.09 (-2.93)	-0.09 (-2.92)	-0.06 (-2.66)	-0.06 (-2.65)	-0.06 (-2.66)	-0.06 (-2.65)	-0.05 (-2.62)	0.05 (2.63)
ln XRATE	0.03 (2.71)	0.02 (2.65)	0.03 (2.70)	0.02 (2.66)	0.02 (2.66)	0.01 (2.52)	0.01 (2.53)		0.01 (2.53)	0.01 (2.52)	0.01 (2.53)	0.004 (2.21)	0.004 (2.21)		0.003 (2.17)	0.004 (2.22)	0.003 (2.17)
ASSASS	-0.001 (-1.87)	-0.001 (-1.86)	-0.001 (-1.86)	-0.001 (-1.86)	-0.001 (-1.86)	-0.007 (-2.30)	-0.007 (-2.27)	-0.007 (-2.28)	-0.007 (-2.30)	-0.007 (-2.26)	-0.007 (-2.29)	-0.01 (-2.44)	-0.01 (-2.43)	-0.01 (-2.44)	-0.01 (-2.44)	0.01 (2.43)	0.01 (2.44)
REVO	-0.005 (-2.15)	-0.004 (-2.09)	-0.004 (-2.11)	-0.004 (-2.10)	-0.004 (-2.10)	-0.01 (-2.37)	-0.01 (-2.38)	-0.01 (-2.38)	-0.01 (-2.36)	-0.01 (-2.38)	-0.01 (-2.38)	-0.03 (-2.25)	-0.03 (-2.27)	-0.03 (-2.27)	-0.02 (-2.27)	-0.03 (-2.27)	-0.03 (-2.28)
R^2	0.85	0.85	0.85	0.84	0.86	0.91	0.91	0.90	0.89	0.89	0.89	0.76	0.75	0.75	0.75	0.74	0.75
N	660	660	660	660	660	1020	1020	1020	960	960	960	900	900	900	840	840	840
AR	0.1124	0.1119	0.1127	0.1132	0.1115	0.1176	0.1149	0.1157	0.1141	0.1149	0.1152	0.11181	0.1167	0.1179	0.1190	0.1162	0.1159
HS	8.22	7.47	7.92	7.26	6.25	10.22	13.6	11.54	9.67	10.26	10.31	13.64	13.15	11.37	14.08	12.66	14.48

Note: Figures in parentheses are heteroschedasticity corrected t-ratio (White, 1981). Ln GDP70 and ln HK70 are initial levels of income per capita and human capital. Trade is ratio of exports and imports in GDP. SW denotes binary openness measure as defined by Sachs and Warner (1995).BLACK is black market premimium. TARIFF is import duty. CTR is collected tax on trade. DISTORT is measure of trade distortion (i.e. $1+t_m$) ($1-t_x$), where t_m and t_x are duties on imports and exports, respectively. AR denote the estimated autocorrelation. Values close to 0 indicate no autocorrelation problem. Due to space restriction we can not report significance levels in this table.

urther Results with Control Variables human capital and infrastructure variables. Fixed effect estimator (1970-1999)

	High-income					Middle-income						Low-income					
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*
lnGDP70	-0.01 (-2.77)	-0.02 (-2.83)	-0.01 (-2.80)	-0.01 (-2.80)	-0.01 (-2.79)	-0.004 (-2.17)	-0.003 (-2.11)	-0.004 (-2.20)	-0.004 (-2.19)	-0.004 (-2.19)	-0.004 (-2.21)	-0.0002 (-1.87)	-0.0003 (-1.90)	-0.0002 (-1.90)	-0.0002 (-1.89)	-0.0003 (-1.93)	-0.0003 (-1.92)
ln HK70	0.03 (3.11)	0.03 (3.12)	0.03 (3.12)	0.02 (3.08)	0.03 (3.12)	0.003 (2.09)	0.003 (2.11)	0.003 (2.10)	0.003 (2.12)	0.004 (2.14)	0.003 (2.12)	0.002 (1.91)	0.002 (1.90)	0.003 (1.93)	0.002 (1.92)	0.002 (1.92)	0.003 (1.93)
ln TRADE	0.25 (3.96)					0.11 (2.54)						0.05 (1.93)					
SW		0.01 (2.73)					0.003 (2.11)						0.0007 (1.65)				
ln BMP								-0.05 (-3.14)						-0.03 (-2.83)			
ln TARIFF			-0.03 (-2.55)						-0.002 (-2.21)						0.001 (2.17)		
Ln CTR				-0.08 (-2.81)						-0.005 (-2.40)						0.001 (1.95)	
Ln DISTORT					-0.05 (-2.68)						-0.004 (-2.32)						0.001 (1.81)
ln GOV	-0.08 (-2.64)	-0.09 (-2.68)	-0.09 (-2.65)	-0.08 (-2.65)	-0.08 (-2.64)	-0.12 (-2.73)	-0.12 (-2.80)	-0.13 (-3.88)	-0.12 (-2.80)	-0.13 (-2.78)	-0.13 (-2.84)	-0.16 (-2.93)	-0.16 (-2.90)	-0.17 (-2.95)	-0.16 (-2.90)	-0.16 (-2.89)	0.16 (2.90)
ln INF	-0.002 (-2.47)	-0.002 (-2.45)	-0.002 (-2.50)	-0.002 (-2.48)	-0.002 (-2.45)	-0.09 (-2.91)	-0.09 (-2.93)	-0.08 (-2.89)	-0.09 (-2.91)	-0.08 (-2.90)	-0.08 (-2.90)	-0.06 (-2.65)	-0.05 (-2.63)	-0.06 (-2.66)	-0.06 (-2.65)	-0.06 (-2.66)	0.06 (2.67)
ln XRATE	0.03 (2.71)	0.02 (2.66)	0.02 (2.67)	0.02 (2.70)	0.02 (2.60)	0.01 (2.53)	0.02 (2.56)		0.01 (2.52)	0.01 (2.53)	0.01 (2.50)	0.004 (2.19)	0.004 (2.20)		0.003 (2.16)	0.004 (2.20)	0.004 (2.21)
ln HK	0.06 (2.53)	0.06 (2.54)	0.07 (2.58)	0.06 (2.54)	0.06 (2.60)	0.09 (2.73)	0.09 (2.71)	0.09 (2.78)	0.08 (2.70)	0.09 (2.71)	0.07 (2.68)	0.03 (2.37)	0.03 (2.35)	0.03 (3.35)	0.04 (3.39)	0.04 (3.38)	0.03 (2.35)
ln INFRA	0.01 (2.77)	0.01 (2.77)	0.01 (2.76)	0.009 (2.74)	0.01 (2.80)	0.005 (2.42)	0.005 (2.46)	0.005 (2.48)	0.004 (2.42)	0.004 (2.44)	0.004 (2.43)	0.002 (2.25)	0.002 (2.26)	0.002 (2.25)	0.002 (2.29)	0.002 (2.28)	0.002 (2.24)
ASSASS	-0.001 (-1.89)	-0.001 (-1.86)	-0.001 (-1.88)	-0.001 (-1.88)	-0.001 (-1.88)	-0.007 (-2.29)	-0.007 (-2.31)	-0.007 (-2.30)	-0.006 (-2.25)	-0.006 (-2.24)	-0.007 (-2.26)	-0.01 (-2.42)	-0.01 (-2.43)	-0.01 (-2.42)	-0.01 (-2.42)	0.01 (2.41)	0.01 (2.42)
REVO	-0.005 (-2.16)	-0.004 (-2.11)	-0.004 (-2.18)	-0.004 (-2.18)	-0.004 (-2.17)	-0.01 (-2.37)	-0.01 (-2.36)	-0.01 (-2.38)	-0.01 (-2.36)	-0.01 (-2.35)	-0.01 (-2.36)	-0.03 (-2.24)	-0.03 (-2.27)	-0.03 (-2.26)	-0.02 (-2.27)	-0.03 (-2.26)	-0.03 (-2.26)
R^2	0.90	0.91	0.90	0.90	0.91	0.94	0.94	0.93	0.95	0.94	0.94	0.81	0.80	0.81	0.81	0.80	0.80
N	660	660	660	660	660	1020	1020	1020	960	960	960	900	900	900	840	840	840
AR	0.1146	0.1138	0.1167	0.1139	0.1191	0.1162	0.1160	0.1164	0.1172	0.1176	0.1194	0.1180	0.1197	0.1382	0.1587	0.1418	0.1594
HS	9.26	8.51	9.12	8.91	8.57	12.19	14.37	12.66	11.09	11.42	12.07	15.22	15.16	14.51	13.27	15.92	16.22

magnitude. Similarly, there are significant changes at least in the size of other openness measures for these countries.

In the case of low-income countries although the impact seems to be minimal, there are some changes in the size as well as the significance levels of openness variables. TARIFF persists to have a significant positive impact on the TFP growth after controlling for macroeconomic and political instability variables. On the other hand, when human capital and infrastructure are included, CTR and DISTORT become insignificant, although they still hold the positive sign. These results suggest that human capital and infrastructure play a significant role in determining the effect of openness by revealing the absorptive capacity of the countries under investigation. The results also show that the effect of human capital is more distinct among middle-income countries. This seems to be in line with the argument that the impact of schooling is non-monotonic as predicted by some studies (e.g. Rogers, 2002).

5.3.8 Effects of control variables

Although the focus of this chapter is to examine the impact of trade on growth, a brief discussion of the parameters associated with other variables is important.

Macroeconomic Variables

The institution and policy variables also seem to play a significant role in determining TFP growth. The ratio of government expenditure in GDP variable has a negative and highly significant effect on growth in all estimated results. This is consistent with other studies (e.g. Barro, 1989, 1990, 1995; Levine and Renelt, 1992). A common interpretation of this is that government consumption does not affect TFP growth directly, but it curtails savings and investments and hence growth through its distortive effect from taxation and spending schemes. We use the ratio of real government expenditure in GDP that excludes the ratio of government expenditure on education and defence to GDP. The reason for this is that as Barro (1995) noted ratio of government spending on education and defence are considered as investment rather than public consumption. The results in Tables 5.11 and 5.12 show that the negative effect of government expenditure is more severe in the low-income countries than in high- and middle-income countries. We may interpret these results by referring to mismanagement in public spending that these countries experienced through repeated changes of government and use of ineffective financial planning.

The estimated results show that inflation has an adverse impact on growth. This is consistent with other findings (Levine and Renelt, 1997; Miller and Russek, 1997; and Bruno and Easterly, 1998). The results provide strong evidence that inflation has a negative impact on growth in all income groups, with its larger effect in the middle-income countries. For example, in regression 6 of Table 5.12 the estimated coefficient of inflation for middle-income countries is -0.09 with t-ratio of -2.91. This implies that a rise in the rate of inflation by one percentage point would lead growth rates to fall by 0.09% per year. The corresponding coefficient (t-ratio) figures for high- and low-income countries is that -0.002 (-2.47) and -0.06 (-2.65), respectively. The main reason for such a high negative effect of inflation in the middle-income countries would be due to the high price fluctuation occurred in the 1970 and 1980s along with extensive policy reforms causing high uncertainty.

As can seen from the regression results, the real exchange rate variable has positive and statistically significant coefficients in every estimated equation. This indicates that an exchange rate that stimulates trade between countries is associated with higher rate of growth.

Political Instability

We included two variables that are considered to measure political instability. The variable REVO measures the number of revolutions and coup d'etat per year. ASSASS, on the other hand, measures the number of political assassinations per year. The results in Tables 5.11 and 5.12 show that both REVO and ASSASS hold negative coefficients in all regressions. However, they are only significant at 10% level in the middle- and low-income countries. These results are similar with other studies (e.g. Barro, 1995; and Harrison, 1996).

5.3.9 Further econometric analysis for low-income countries

In Chapter 4, we have noted that low-income countries may need more development aid that will enable them to increase their absorptive capability. This argument is based on the theoretical aid-tariff relationship developed by Lahiri and Raimondos-Moller (1997) and the assumption that LDCs need some extra help to build better infrastructure and schools. We have carried out empirical tests by including the ratio of foreign aid in GDP (AID) and the interaction terms between AID and TARIFF, AID and CTR and AID and DISTORT. Furthermore, we assume that the positive effect of TARIFF, CTR and DISTORT may be associated with their impact on the import substitution strategy. To test this argument we have included a proxy for manufacturing output, ratio of industrial output in GDP (IND). Table 5.13 presents results that incorporate AID, IND, and their interactive terms with TARIFF, CTR and DISTORT.

The regression results provide strong evidence that AID makes a positive contribution to TFP growth in low-income countries. For example, in equation 1 of Table 5.13 a 1% increase in foreign aid for low-income countries would induce TFP growth by 0.05%. This suggests that there is much dependence by low-income countries on foreign help. This could be both in

Table 5.13

Testing for Interaction between Openness and Aid, and Openness and Industrial Output

Dependent Variable: TFP growth (Fixed effect estimator) 1970-1999

	1	2	3	4	5	6	7	8
lnGDP70	-0.0002 (-1.87)	-0.0002 (-1.86)	-0.0003 (-1.91)	-0.0003 (-1.88)	-0.0003 (-1.87)	-0.0003 (-1.87)	-0.0004 (-1.91)	-0.0003 (-1.88)
ln HK70	0.002 (1.91)	0.002 (1.91)	0.002 (1.92)	0.001 (1.89)	0.001 (1.87)	0.001 (1.84)	0.002 (1.94)	0.001 (1.90)
ln TARIFF	0.004 (2.32)	0.001 (2.09)					0.004 (2.30)	0.001 (2.15)
ln CTR			0.001 (1.97)	0.0007 (1.86)				
ln DISTORT					0.001 (1.82)	0.00008 (1.76)		
ln AID	0.05 (2.61)	0.02 (2.44)	0.05 (2.63)		0.05 (2.61)	0.02 (2.50)		
*ln AID*ln TARIFF*		-0.06 (-2.39)						
*ln AID*CTR*				-0.003 (-2.41)				
*ln AID*DISTORT*						-0.002 (-1.92)		
ln IND							0.09 (2.63)	0.03 (2.31)
*ln IND*ln TARIFF*								-0.007 (-1.83)
ln GOV	-0.17 (-2.95)	-0.16 (-2.91)	-0.16 (-2.92)	-0.16 (-2.88)	-0.17 (-2.93)	-0.16 (-2.87)	-0.15 (-2.79)	-0.15 (2.77)
ln INF	-0.06 (-2.66)	-0.06 (-2.67)	-0.06 (-2.67)	-0.06 (-2.66)	-0.06 (-2.67)	-0.06 (--2.66)	-0.09 (-2.79)	-0.09 (-2.79)
ln XRATE	0.002 (2.10)	0.002 (2.08)	0.004 (2.21)	0.003 (2.16)	0.002 (2.11)	0.002 (2.13)	0.003 (2.18)	0.002 (2.14)
ln HK	0.04 (2.38)	0.04 (2.37)	0.04 (2.35)	0.04 (2.35)	0.03 (2.31)	0.03 (2.33)	0.05 (2.35)	0.05 (2.34)
ln INFRA	0.002 (2.31)	0.002 (2.33)	0.001 (2.24)	0.001 (2.24)	0.001 (2.23)	0.001 (2.23)	0.001 (2.35)	0.001 (2.35)
ASSASS	- -0.01 (-2.38)	-0.01 (-2.36)	-0.01 (-2.38)	-0.01 (-2.38)	-0.01 (2.37)	-0.01 (-2.37)	-0.01 (-2.34)	-0.01 (-2.36)
REVO	-0.02 (-2.27)	-0.02 (-2.26)	-0.03 (-2.26)	-0.02 (-2.23)	-0.02 (-2.25)	-0.02 (-2.27)	-0.03 (-2.21)	-0.03 (-2.23)
R^2	0.86	0.88	0.85	0.88	0.86	0.89	0.84	0.88
N	840	840	840	840	840	840	840	840
AR	0.1692	0.1721	0.1538	0.1717	0.1605	0.1883	0.1519	0.1871
HS	16.52	19.07	14.19	16.61	15.27	19.80	13.04	16.54

Note: Figures in parentheses are heteroschedsticity consistent t-values. ln GDP70 and ln HK70 represent initial levels of income per capita and human capital. ln TARIFF is import duties, ln CTR is ratio of collected tax on international trade to total revenue, ln DISTORT is trade distortionay measure defined as $(1+t_m)/(1-t_x)$, where t_m and t_x denote duties on imports and exports, respectively. ln AID is ratio of foreign aid to GDP. ln GOV is rato of government spending to GDP. Ln INF is rate of inflation. Ln XRATE is foreign exchange rate. Ln HK is human capital. Ln INFRA is infrastructure. ASSASS is number of political assassinations per year. REVO is number of revolutions and coup deta per year. AR denotes the estimated autocorrelation coefficient, values ranging between -1 and 1. Values close to 0 indicate no autocorrelation problem. HS is White's test for heterschedasticity. Due to space restriction we do not report the significance levels in this table.

terms of food as it contributes in keeping the working force more healthy and productive or in terms of capital goods or financial help that can be used directly for production or other development purpose, such as building up better quality of infrastructure and schools.

The interaction term between AID and the trade distortive measures included in the regression hold negative signs and, with the exception of AID*DISTORT, they are statistically significant at 10% level. The interpretation for these results would be that low-income countries need more foreign aid in order to benefit from openness by removing restrictive trade policy measures. In other words, cutting duties in trade should be accompanied by a significant flow foreign development aid. As we hypothesise earlier low-income countries need more development aid that would help to develop their absorptive capacity by improving their infrastructure (building schools, hospitals, etc)

In equation 7 of Table 5.13 show that IND has a significant positive impact on TFP growth; that is, if the ratio of industrial output increases by 1% TFP would grow by 0.09%. This could be taken as indicative that industrial expansion has a significant contribution in the growth process of low-income countries. The interactive term between IND and TARIFF is negative, though not significant. This implies that the result does not support the import substitution argument at least in case of our sample of low-income countries.

5.4 Conclusions

This chapter has examined the impact of trade and trade liberalisation on factor productivity of 86 countries for the period 1970-1999, with particular emphasis on its impact in low-income countries. This chapter is essentially an extension of Chapter 4, and uses panel data and six alternative openness variables TRADE (ratio of export + import to GDP), SW (the binary index developed by Sachs and Warner, 1995), BMP (black market premium), TARIFF (duties on imports), CTR (the ratio of total revenues on trade taxes to total trade) and DISTORT ($1+t_m/1-t_x$, where t_m is duties on imports and t_x is duties on exports).

As in Chapter 4, we began the analysis with the panel regression of GDP growth on growth of labour and capital to obtain total factor productivity estimates from the residuals. Using the full sample of 86 countries, we then carried out testing various specifications for the entire period (1970-1999) and also for three sub-periods (1970-1979, 1980-1989 and 1990-1999). Then the sample of 86 countries was divided into three groups (high-, middle- and low-income) to examine whether the results obtained for full sample of 86 countries hold for groups of countries that differ in their level of development. Furthermore, we tested the impact of our level of development indicators (human capital and infrastructure) by including them in the regressions and also interacting them with trade and trade related variables. The robustness of the results have also been tested by controlling for some macroeconomic [ratio of government expenditure in GDP (GOV), rate of inflation (INF) and exchange rate (XRATE)] and political instability [number of political assassinations per year (ASSASS) and number of revolutions and *coup d'etat* per year (REVO)] variables.

The results for the full sample of countries (that includes 22 high-income, 34 middle-income and 30 low-income countries) indicate that trade and trade-related variables have a significant impact on TFP growth. All six openness variables hold the expected signs and they are statistically significant. These findings are consistent with other studies that found a positive impact of openness on growth (e.g., Dollar, 1992; Harrison, 1996 and Edwards, 1992, 1998). Based on these results one can suggest that openness is positively associated with TFP growth. Furthermore, it is revealed that the magnitude of openness indicators is higher in the 1990s than that in the 1980s and 1970s, and that the magnitude is greater in the 1980s than that in the 1970s. This seems to suggest that countries benefit from openness as they go through some process of economic development.

More compelling results are revealed by the regressions for the different groups of countries when the sample has been divided into high-, middle- and low-income countries. With respect of high-income countries, it is not surprising to find strong evidence that supports the hypothesis that openness is positively associated with growth. All openness indicators hold the expected signs and they all are highly significant. Moreover, the results for initial levels of per capita income indicate that there is highly significant convergence taking place among high-income countries. It is, however, interesting to observe the pattern of the impact of trade and trade-related variables as we move from one period to another. The impact of openness seems to be higher in the 1990s than that in the 1980s and 1970s, and that the magnitude is grater in the 1980s than that in the 1970s both in terms of size and significance levels.

In the case of middle-income countries, the results are more compelling. For the entire sample period (1970-1999) the results show that openness is positively associated with TFP growth, since all trade and trade related variables hold the expected signs and they all are statistically significant. However, the results for the three sub-periods reveal a different story. In the 1970s only three out of six trade and trade-related variables (BMP, CTR and DISTORT) are statistically significant. In the 1980s there is significant but weak correlation between trade and TFP growth. With the exception of SW, the remaining five are statistically significant. In the 1990s all trade and trade-related variables are significant at least at the 5% level. In general, both the magnitude and significance levels of trade-related variables were continuously increasing from one period to another. This again gives strong support to the hypothesis that as economic development takes place, (and thus, as the stock of human capital is accumulated and as improvement in infrastructure takes place) openness has a greater impact on economic growth.

In the low-income countries the results show that there is no positive correlation between openness and productivity growth. For the period 1970-1999, the results show that the only variable that holds the right sign which is statistically significant is BMP. On the other hand, TARIFF, CTR and DISTORT have unexpected positive signs and they are statistically significant at conventional levels. The results for the three sub-periods exhibit more interesting results. In the 1970s TRADE seems to be negatively associated with TFP growth in the low-income countries, although its impact is not statistically significant at conventional levels. TARIFF, CTR and DISTORT hold positive sign and they all are significant at conventional levels. In the 1980s and 1990s TRADE maintains its positive sign, though not statistically significant. TARIFF, CTR and DISTORT are consistently positive although their magnitude is smaller in the 1990s than that in the 1980s and 1970s, and the magnitude in the 1980s is smaller than that in the 1970s. The only trade-related variables with little changes in its impact from one period to another is BLACK. As we noted in Chapter 4, the validity of black market premium as trade policy variable is questionable, since it is determined by other factors, such as excess demand and mismanagement. The results for the initial level of per capita income indicates that there is no significant convergence taking place in low-income countries.

We have also seen that human capital (HK) and infrastructure (INFRA) play a significant role in determining the impact of openness on productivity growth. We have examined their effect by using interactive terms between HK, INFRA and trade related variables. In high- and middle-income countries the interactive terms are highly significant, while they are weak in the low-income countries. This implies that the stock of human capital and quality of infrastructure in low-income countries are not adequate in order to reap benefits from trade liberalisation.

The estimated positive coefficient of TARIFF prompted us to carry out further empirical tests to examine two basic issues that are related to low-income countries: (1) the impact of foreign aid [the ratio of aid to GDP (AID)] on economic growth and also the interaction effect of TARIFF and foreign aid as postulated by Lahiri and Raimondos-Moller (1997); (2) whether import substitution [proxied by IND which is the ratio of industrial output to GDP] is an alternative trade policy strategy for low-income countries. The effect of import substitution is tested by including interaction between TARIFF and ratio of manufacturing output to GDP (IND). The results show that AID has significant positive impact on productivity growth. On the other hand, the interactive term between TARIFF and AID holds negative sign and it is statistically significant at the conventional level, implying that higher aid flows are negatively associated with TARIFF. That is, the increase in AID would help low-income countries to reduce tariff rates and liberalise their trade with the rest of the world. The interactive term between TARIFF and IND has a negative coefficient, although it is not statistically significant. This implies that import substitution is not an alternative strategy for low-income countries.

The results in this chapter are consistent with the previous chapter and shows that openness has a strong positive impact on productivity growth of high- and middle-income countries, but weak or no significant effect with respect to low-income countries. The result seems to be robust at least when controlling for some macroeconomic and political instability variables. The regression results show that a good macroeconomic environment plays a significant role in determining productivity growth. For groups of countries government expenditure has a highly significant negative impact on TFP growth, with its greater impact in the low-income countries. We noted that this could be due to the mismanagement in public spending that these countries experienced through continuous change of governments and ineffective financial planning. Inflation also has an adverse effect on TFP growth in all groups of countries, with its greater impact in the middle-income countries. As noted earlier, this could be due to relatively higher price fluctuation occurred during the 1970s and 1980s when extensive policy reforms were carried out. Exchange rate seems to be positively associated with TFP growth of all groups of countries, although its magnitude is greater in the high-income countries. Political instability variables (ASSASS and REVO) hold negative coefficients in all regression, but they impact is only statistically significant in the case of middle- and low-income countries.

We may have to note here that our results might also be subjected to alternative measure of level of development, such as education or infrastructure threshold. It may worthwhile to test the results when such data are available. Furthermore, as noted in Chapter 4, we our estimates of total factor productivity growth can only give approximate values due to the strong homogeneity assumption in technology across the countries. Nevertheless, we believe that the main findings in this chapter or Chapter 4 will not alter to a different technique used to measure TFP.

CHAPTER 6

Exports and Economic Growth

6.1 Introduction

This chapter carries out empirical tests of the impact of exports on economic growth using Feder's (1983) neoclassical model for a sample of 91 countries. The model suggests that there are two main ways through which exports affect economic growth: one is the externality effect of the export sector on the non-export sector, and the other is the productivity differential effect. Following Feder's method, other researchers (Ram, 1985, 1987; Helleiner, 1987;) find different sets of results for different samples. Ram (1985,1987), for example, found results that support the export-led hypothesis, while Helleiner (1987) found no statistical association between exports and economic growth for the sample of African countries (see Chapter 2 for detailed empirical literature review).

As in the previous two chapters, we approach our analysis by hypothesising that the impact of openness, and export (mainly manufacturing export in the case of this chapter), is facilitated by the country's stage of development as determined by their human capital endowment and quality of infrastructure. Feder's model assumes two sectors in the economy - one producing for the global market (export sector), while the other is selling its product at the domestic market (non-export sector). The non-export sector is assumed to benefit from better production techniques and management skills that prevail in the export sector. Our hypothesis states that for countries (or non-export sector) to benefit from openness (or export sector) they need to be well endowed with human capital and have high quality infrastructure. We will use both cross-country and panel data regression to analyse the impact of export on growth for the period 1970-1999.

6.2 Stylised Facts

In this section we discuss the stylised facts of exports performance and economic growth in 91 countries over the 1970-1999 period. We divide sample periods into three sub-periods (a)

Table 6.1

Summary statistics of export and economic growth

	N	Economic Indicators	1970-1999	1970-1979	1980-1989	1990-1999
All sample	91	Real per capita GDP	4719	4077	4961	5118
		Export-GDP ratio	0.349	0.231	0.304	0.511
		Gross investment-GDP ratio	0.627	0.594	0.664	0.623
		Annual growth rate of GDP	4.4	3.8	4.3	5.1
		Annual growth rate of export	7.1	2.2	10.5	8.7
		Annual growth rate of population	3.7	3.4	3.9	3.7
High-income	26	Real per capita GDP	15647	12514	15733	18694
		Export-GDP ratio	0.519	0.414	0.496	0.647
		Gross investment-GDP ratio	0.502	0.437	0.471	0.599
		Annual growth rate of GDP	4.2	4.7	4.2	3.8
		Annual growth rate of export	7.7	5.3	8.7	9.1
		Annual growth rate of population	1.6	1.8	1.6	1.4
Middle-income	36	Real per capita GDP	3638	3118	3692	4104
		Export-GDP ratio	0.091	0.097	0.095	0.080
		Gross investment-GDP ratio	0.109	0.099	0.117	0.110
		Annual growth rate of GDP	2.2	2.1	2.4	2.2
		Annual growth rate of export	10.3	2.4	13.7	14.8
		Annual growth rate of population	2.4	2.5	2.4	2.4
Low-income	29	Real per capita GDP	631	501	683	709
		Export-GDP ratio	0.026	0.021	0.025	0.033
		Gross investment-GDP ratio	0.027	0.022	0.024	0.036
		Annual growth rate of GDP	2.6	3.8	1.8	2.1
		Annual growth rate of export	5	2.7	5.9	6.4
		Annual growth rate of population	2.9	2.6	2.9	3.1

Source: Own calculation

1970-1979, the period when most developing countries employed restrictive trade policy, (b) 1980-1989, the period when most developing countries undertook policy reforms, and (c)1990-1999. During 1970-1979 most developing countries employed a restrictive regime that includes pegged foreign exchange, and import substitution industrialisation, import control, and exchange controls.

Table 6.1 presents the statistical properties of the data for each sample period. Real per capita income and investment-GDP ratio were higher in the 1990s than the 1980s and 1970s. The cumulative growth rate of GDP for all sample countries has increased from 3.8% in 1970-1979 to 4.3% in 1980-1989 despite a considerable increase in the growth rate of exports (2.2% to 10.5%) over the same period. This could be seen as suggesting that there is a weak relationship between GDP growth and export growth. Moreover, the average annual growth rate of exports is higher in the 1980s than in the 1990s, which does not support the notion that outward-oriented economies tend to improve their export performance. The descriptive statistics given in Table 6.1 show that despite policy reforms and changes in export growth, GDP growth remained dismal in most developing countries. In the 1970s low-income countries experienced GDP growth of 3.8% per year and export growth of 2.7%. During the 1980s export has risen to an average growth rate of 5.9%, while GDP growth has fallen to 1.8%.

Table 6.2 presents further evidence on the relationship between exports and economic growth. Since export is a component of GDP we may expect a high correlation coefficient between export and GDP. The correlation coefficient between GDP growth and ratio of export to GDP for the full sample countries is 0.614 for the period 1970-1999. The results show that the correlation between these variables is quite small in the low-income countries (0.29) compared to the figures of 0.87 for high-income and 0.69 for middle-income countries. With respect to low-income countries, the correlation between the average GDP growth and growth of exports also reveals that there seems to be negative correlation between these two variables although the figures are very low. The results show that the correlation between GDP growth and growth of exports is greater among the high-income countries. Interestingly, the correlation between GDP growth and growth of export is greater in the 1990s than the 1970s for all income groups. This confirms a positive correlation between the two variables. Further results, however, reveal that the

Table 6.2

Correlation between Export and Economic Growth

	N		1970-1999	1970-1979	1980-1989	1990-1999
All sample	91	GDP and share of export in GDP	0.614	0.560	0.618	0.652
		Growth rate of GDP and growth rate of export	0.474	0.407	0.462	0.553
		Growth rate and weighted growth rate of export	0.452	0.406	0.437	0.514
High-income	26	GDP and share of export in GDP	0.868	0.891	0.829	0.864
		Growth rate of GDP and growth rate of export	0.847	0.846	0.825	0.866
		Growth rate and weighted growth rate of export	0.826	0.796	0.824	0.859
Middle-income	36	GDP and share of export in GDP	0.687	0.539	0.750	0.761
		Growth rate of GDP and growth rate of export	0.631	0.508	0.682	0.704
		Growth rate and weighted growth rate of export	0.573	0.511	0.598	0.610
Low-income	29	GDP and share of export in GDP	0.286	0.251	0.275	0.331
		Growth rate of GDP and growth rate of export	0.055	-0.119	0.104	0.152
		Growth rate of GDP and weighted growth rate of export	0.042	-0.05	0.07	0.095

Source: Own calculation

correlation coefficient for the period 1980s and the 1990s is quite similar despite policy reforms being undertaken during the 1980s. These findings can be taken as suggestive of the proposition that the nature of policy regime may not be a crucial factor by itself in determining the impact of exports on growth. We shouldn't, however, take these results as conclusive since the correlation analysis does not take the effects of other factors into consideration.

6.3 The Model

This section presents the analytical framework. There are two channels through which exports are assumed to affect economic growth – the externality effect and the productivity differential effect. The exports sector operates in a highly competitive global market and to succeed in such international competition they need to improve their production techniques, management skill and infrastructure. There are two main ways through which the non-export sector benefits from the exports sector. First, the non-export sector can replicate the management skill, production technique and marketing strategy from the export sector.

Second, the non-export sector may get access to the public transport and other means of communication developed for the export sector. These costless benefits to the non-export sector are referred to as the positive production externality of the export sector

Factor productivity may differ between the export and non-export sectors for two reasons. First, the export sector use better production techniques and skilled manpower. Second, due to differential skill requirements, factors of production are not perfectly mobile between the two sectors. In the absence of perfect factor mobility, marginal factor productivity is higher in the export sector than in the non-export sector. Since the export sector employs more skilled work force than the non-export sector, there would be significant productivity gap between the two sectors. It can then be argued that export expansion may increase total factor productivity through its impact on the efficiency of resource allocation.

The production function is assumed to differ between the two sectors but remain the same within sectors. Resource allocation between the two sectors is non-optimal due to the non-priced externalities and factor mobility. Adopting Feder's (1983) theoretical framework, the production functions of the two sectors are expressed as follows:

$$Y = N + X \tag{6.1}$$

$$N = f(K_N, L_N, X) \tag{6.2}$$

$$X = g(K_X, L_X), \tag{6.3}$$

where Y is the domestic product, which is the sum of the non-export (N) and export (X) sectors output; K_N and K_X denote sector specific capital stock, and L_N and L_X are sector specific labour inputs.

Taking the total differential of equations (6.1) and (6.2) we get:

$$dN = F_K dK_N + F_L dL_N + F_X dX \tag{6.4}$$

$$dX = G_K dK_X + G_L dL_X \tag{6.5}$$

where F_i and G_i (i=K,L) represent the marginal productivities of input i (capital and labour) in non-export and export sectors respectively. F_X is the marginal externality effect of X on N. Applying the assumption that the marginal factor productivity differs between the two sectors and assuming further that factor productivity of exports sector differs from non-export sectors by a factor δ we get:

$$G_i = (1+\delta)F_i \tag{6.6}$$

Substituting equations (6.4) and (6.5) into the identity $dY = dN + dX$, we get:

$$dY = F_K dK_N + F_L dL_N + F_X dX + G_K dL_X + G_L dK_X \tag{6.7}$$

$$= F_K dK_N + F_L dL_N + F_X dX + (1+\delta)G_X dK_X + (1+\delta)G_L dL_X \tag{6.8}$$

$$= F_K (dK_N + dK_X) + F_L (dL_N + dL_X) + F_X dX + \delta(G_K dK_X + G_L dL_X) \tag{6.9}$$

Define total investment as $I = dK_N + dK_X$, total labour growth as $\dot{L} = dL_N + dL_X$, $dX = \dot{X}$ and substituting in equation (6.9) we get:

$$\dot{Y} = F_K I + F_L \dot{L} + F_X \dot{X} + \delta(G_K dK_X + G_L dL_X) \tag{6.10}$$

Using equation (6.5) and (6.6) we get the following expression:

$$F_K I_X + F_L \dot{L}_X = \frac{1}{1+\delta}(G_K I_X + G_L \dot{L}_X) = \frac{\dot{X}}{1+\delta} \tag{6.11}$$

Using this result in equation (6.9), we get:

$$\dot{Y} = F_L \dot{L} + F_K I + \left(\frac{\delta}{1+\delta} + F_X\right)\dot{X} \tag{6.12}$$

Assuming a linear relationship between the real marginal productivity of labour in a given sector and average output per worker expressed as:

$$F_L = \beta(Y/L) \tag{6.13}$$

Dividing equation (6.12) through by Y gives:

$$\frac{\dot{Y}}{Y} = \alpha\left(\frac{I}{Y}\right) + \beta\left(\frac{\dot{L}}{L}\right) + \left(\frac{\delta}{1+\delta} + F_X\right)\left(\frac{\dot{X}}{X}\frac{X}{Y}\right) \tag{6.14}$$

where $\alpha = F_K$ and $[(\delta/1+\delta) + F_X]$ is the sum of the productivity differential and the production externality effect. The term $(\dot{X}/X)(X/Y)$ can be interpreted as the weighted exports growth (that is, the export growth rate weighted by the share of export in GDP). Equation (6.14) states that the growth rate of GDP is a function of growth rate of labour, the investment-GDP ratio and the weighted growth rate of exports.

Marginal productivity of each factor (capital and labour) is determined by its productivity in the non-export sector, the magnitude of the productivity differential and factor allocation across the two sectors. Using equation (6.10), we can derive the marginal productivity of the two factors:

$$MP_K = F_K I + \delta(F_K + dK_X) \qquad (6.15)$$

Denoting $dK_X = I_X$ equation (14) yields:

$$MP_K = F_K\left(1 + \delta\frac{I_X}{I}\right) \qquad (6.16)$$

Similarly, we find marginal productivity of labour as:

$$MP_L = F_L\left(1 + \delta\frac{L_X}{L}\right) \qquad (6.17)$$

where I_x/I is ratio of export sector's investment to total investment, and L_X/L is the share of labour force increase in the export sector. If $\delta = 0$ in equation (6.14), that is, no productivity differential between the two sectors) or more labour force is employed only in the non-export sector, the marginal productivity of a factor for the whole economy will be the same as the marginal productivity of the non-export sector.

6.4 Empirical Results

We begin the regression analysis by estimating equation (6.14) for 88 sample countries. We regress rate of growth of GDP on the ratio of investment to GDP, growth of labour and the product of exports growth and share of exports in GDP. The regression analysis includes 25 high-, 36 middle- and 30 low-income countries as defined by the World Bank's (see Appendix 11 for the list). We begin our analysis by taking decade long averages of observations (1970-1979, 1980-1989 and 1990-1999). We then extend the analysis by using panel data for the period 1970-1999. In both cross-section and panel regressions we also examine the robustness of the export by controlling for other variables.

We adopt the following empirical specification to be estimated:

$$\dot{Y} = \alpha_0 + \alpha(I/Y) + \beta\dot{L} + \gamma(X/Y)\dot{X} + \varepsilon \qquad (6.17)$$

where ε is the error term and a dot ($\cdot$) over a variable denotes the annual growth rate. Equation (6.17) states that growth of GDP is a function of ratio of investment in GDP, growth of labour force and growth of exports multiplied by exports share in GDP. The marginal productivity of capital (α) is expected to be positive. The coefficient of growth of labour force is also expected to be positive unless labour surplus created an adverse effect during the study period. We noted earlier that marginal productivity of the export sector is higher than the export sector (due to the use of skilled labour force and better production technique) and non-export sector. Based on this argument we expect α_3 to be greater than zero.

6.4.1 Cross-section results

A set of estimated parameters of equation (6.17) for a sample of 91 countries is reported in Tables 6.3-6.10. Initially, we apply the OLS estimator to estimate the model (equation 6.17) with and without human capita and infrastructure variables. Table 6.3 presents estimated results for the period 1970-1979. The results for full sample show that the model is a good fit. In all three regressions the R^2s are adequately high to suggest that the variation in GDP growth is well explained by the model. The F-statistics indicate that the explanatory variables are jointly significant. Furthermore, the White tests do not reject the null hypothesis for homoschedasticity. As can be seen from Table 6.3 the estimated coefficients of all variables hold the expected signs and they all are statistically significant at conventional levels. The estimated coefficients of labour and capital are in the expected range as found by other studies Pesmazogen (1972), Ram (1985, 1987), Feder (1983) and others. Ratio of investment to GDP is positive and statistically significant at 1% level. The results show that growth of labour force also have significant contribution to GDP growth. Above all, to the interest of this study the estimated coefficient of $(\dot{X})(X/Y)$ is positive and significant at 1 percent level suggesting that the marginal factor productivity in the export sector is higher than in the non-export sector. As we noted earlier the non-zero coefficient of $(\dot{X})(X/Y)$ indicates externality effect of exports sector on non-export sector. In formulation of the coefficient of $(\dot{X})(X/Y)$ we have $(\frac{\delta}{1+\delta}+F_X)$ as a

Table 6.3

Cross-country regression for a sample of both developed and developing countries (Dependent variable is growth rate of GDP (1970-1979)

	Full sample			Developed countries			Developing countries		
Eq. No.	1	2	3	4	5	6	7	8	9
Constant	0.002	0.004	0.01	0.005	0.003	0.002	0.003	0.001	0.006
	(0.976)	(1.13)	(1.68)	(1.29)	(1.47)	(1.89)	(0.448)	(1.10)	(0.719)
I/Y	0.19***	0.17***	0.16***	0.12***	0.11***	0.10***	0.16***	0.16***	0.15***
	(3.15)	(3.10)	(3.09)	(3.36)	(3.32)	(3.27)	(2.83)	(2.85)	(2.80)
$\dot{L}/L$	0.57***	0.55**	0.54**	0.64***	0.64***	0.65***	0.56**	0.54**	0.55**
	(2.71)	(2.65)	(2.62)	(2.81)	(2.82)	(2.86)	(2.67)	(2.59)	(2.62)
$(\dot{X})(X/Y)$	0.26***	0.29***	0.28***	0.38***	0.46***	0.35***	0.11*	0.13**	0.08*
	(2.93)	(3.15)	(2.84)	(3.31)	(3.39)	(3.18)	(2.24)	(2.35)	(2.15)
HK		0.04***	0.03**		0.07***	0.05***		0.01**	0.008**
		(2.72)	(2.61)		(3.08)	(2.96)		(2.49)	(2.41)
INFRA		0.02**	0.008**		0.06***	0.05***		0.008**	0.004*
		(2.63)	(2.49)		(2.92)	(2.78)		(2.41)	(2.33)
INTER			0.09**			0.14**			0.06*
			(2.41)			(2.63)			(2.29)
R^2	0.61	0.72	0.78	0.70	0.79	0.82	0.44	0.48	0.53
F-value	15.7	13.9	22.7	18.4	21.7	38.9	10.2	14.7	18.4
N	91	91	91	22	22	22	69	69	69

*Note: Here we use Feder's (1983) model. I/Y = GDI/GDP, $\dot{L}/L$ is growth of labour, $\dot{X}/X$ is growth of export, X/Y is ratio of export to GDP, HK is human capital INFRA is infrastructure, and INTER (is the interaction term between exports, and human capital and infrastructure) = $[(\dot{X})(X/Y)]$ * HK* INFRA. A separate regression was run using an interaction term between openness parameter and HK, and openness and INFRA separately, but the results are fairly similar. Figures in parentheses are t-values. *** , ** and * denote respectively the 1 percent, 5 percent and 10 percent level of significance*

coefficient, and we noted that if $\delta = 0$, it indicates that the marginal productivities are equalised across countries, and when $F_X = 0$, it implies that there are no inter sectoral externality. Since we have a positive coefficient for $(\dot{X})(X/Y)$, we can interpret the result that factor productivity is higher in the export sector and also export sector has significant positive externality effect on the non-export sector.

To investigate the impact of human capital and infrastructure in the process of growth, we carried out further regressions that incorporate these variables. The results (column 2 of Table 6.3) show that following the inclusion of human capital and infrastructure variables R^2 has increased from 0.61 to 0.72, indicating the significance of these variables in explaining the GDP growth. The results show that a 1% increase in stock of human capital would stimulate GDP growth by 0.04%. The corresponding figure for infrastructure effect is 0.02%. Furthermore, after controlling for human capital and infrastructure the coefficient and significance level of the openness measure has increased slightly. This seems to suggest that human capital and infrastructure has important role in determining the positive effect of exports on GDP growth.

As noted earlier, we carry out further regressions that include the interactive term between human capital, infrastructure and openness measure. This is expected to capture the effect on GDP growth of the simultaneous increase in human capital, infrastructure along with openness measure. The results (column 3 of Table 6.3) show that the interactive term has a positive coefficient, which is significant at 5% level. This indicates that the higher the level of human capital and quality of infrastructure the greater the benefit will be from openness. As noted in the previous chapters, empirical analysis of this kind need to divide sample countries in to groups based on their stages of development to investigate if the results obtained in Table 6.3 is universally applicable. We run the regression for each group and the results are presented in column 4-9 of Table 6.3.

With respect to developed countries, in all regression the R^2s show that the model is good fit in explaining GDP growth. Since F-test statistics values are greater than the critical value of 2.69, we reject the null hypothesis at 1% level concluding that independent variables are jointly significant. The estimated coefficients of ratio of investment to GDP and growth of labour force are positive and significant at 1% level. The regression results show that openness measure has a significant impact on GDP growth in high-income countries, supporting the hypothesis that export sector has an externality effect on non-export. In column 5 of Table 6.3, the estimated results show that human capital and infrastructure have a significant positive impact on GDP growth in developed countries. For example, a 1% increase in human capital stimulates GDP growth by 0.07%. A further regression that includes the interactive term between human capital, infrastructure and openness variables indicates that human capital and infrastructure play important role in determining the effect of openness on GDP growth. That is, higher stock of human capital and better quality of infrastructure are positively associated with openness in affecting GDP growth.

Turning to the regression results for developing countries, the R^2s, in all regressions, indicate that at least 44% of the sample variation in GDP growth is explained by the independent variables. The F-test statistics also show that, in all regressions, the independent variables are jointly significant. Ratio of investment to GDP and growth of labour force have positive coefficients which are significant at 1% and 5% levels, respectively. As suggested by the neoclassical growth models, the estimated coefficient of ratio of investment to GDP is greater in developing countries than in developed countries. This supports the idea that in labour abundant developing countries the rate of return to capital is relatively higher in these countries compared to developed countries. The estimated results of openness variable provide strong evidence in support of its positive contribution to GDP growth. However, the results reveal that the magnitude of the impact of exports growth is much higher in the developed countries compared to developing countries. As in high-income countries, the inclusion of human capital and infrastructure led R^2 to increase significantly, implying the important role of these variables in explaining the changes in GDP. Moreover, following the inclusion of human capital and infrastructure variables, the size and significance level of openness measure has increased from 0.11 to 0.13 and from 2.24 to 2.35. This indicates that human capital and infrastructure are important factors in determining the effect of openness in the growth process of developing countries. In column 9 of Table 6.3 the interactive term is positive and significant at 10% level, implying the simultaneous increase in human capital, infrastructure and openness. This can be interpreted as indicating that human capital endowment and infrastructure have an important role for making openness to work. Although the results suggest that the exports growth variables have a positive impact in both samples, the magnitude and significance level is weaker in the case of the developing countries.

To examine whether the results obtained in Table 6.3 hold for all developing countries, we carry out further regression by dividing developing countries into two groups (middle- and low-income). Table 6.4 presents the estimated results for groups of middle- and low-income countries. In all regressions the R^2s show that fair proportion of the variation in GDP growth is explained by the model. The F-statistics indicate that the independent variables are jointly significant.

Table 6.4

Cross-country regression for a sample of Middle-income countries. Dependent variable is growth rate of GDP. (1970-1979)

.	Middle-income			Low-income		
	1	2	3	4	5	6
Constant	0.001 (0.319)	0.0021 (0.669)	0.002 (1.21)	-0.006 (-1.43)	0.0005 (0.273)	0.001 (1.14)
I/Y	0.15*** (3.39)	0.13*** (3.25)	0.13*** (3.26)	0.19** (2.58)	0.18** (2.51)	0.17** (2.46)
$\dot{L}/L$	0.59** (2.51)	0.59** (2.49)	0.58** (2.46)	0.50*** (2.81)	0.49*** (2.76)	0.48*** (2.76)
$(\dot{X})(X/Y)$	0.26** (2.54)	0.30** (2.68)	0.23*** (3.46)	-0.006 (-0.713)	-0.004 (-0.118)	-0.007 (-0.895)
HK		0.03** (2.66)	0.02** (2.58)		0.01** (2.35)	0.007* (2.24)
INFRA		0.01** (2.54)	0.008** (2.47)		0.003* (2.28)	0.001* (2.18)
INTER			0.11** (2.40)			0.005 (1.89)
R^2	0.52	0.58	0.69	0.34	0.38	0.40
F-value	13.1	11.3	19.9	3.6	9.4	13.1
N	37	37	37	32	32	32

*Note: Here we use Feder's (1983) model. I/Y = GDI/GDP, $\dot{L}/L$ is growth of labour, $\dot{X}/X$ is growth of export, X/Y is ratio of export to GDP, HK is human capital INFRA is infrastructure, and INTER (is the interaction term between exports, and human capital and infrastructure) = $[(\dot{X})(X/Y)]$ * HK* INFRA. A separate regression was run using an interaction term between openness parameter and HK, and openness and INFRA separately, but the results are fairly similar. Figures in parentheses are t-values. ***, ** and * denote respectively the 1 percent, 5 percent and 10 percent level of significance*

The estimated results show that ratio of investment to GDP and rate of growth of labour have a significant contribution to GDP growth. Nevertheless, the magnitude of the impact of I/Y is higher in the low-income countries than the middle-income countries. The contribution of growth rate of labour, on the other hand, seems to higher in the middle-income countries compared to the low-income countries. For middle-income countries the estimated coefficient of the exports growth measure is positive and significant at 5% level. However, the size of the coefficient is about half of the estimated coefficient exports growth for high-income countries. More interestingly, the results show that during the 1970-1979 exports growth did not have positive contribution to GDP growth of low-income countries. Indeed, the coefficient of the exports growth is negative, though not statistically significant. When human capital and infrastructure variables are included in the regression, the size and t-value of exports growth has improved in the case of middle-income countries. In the case of low-income countries, although the size of the coefficient has decreased, it still maintains the negative sign. In column 3 and 6 of Table 6.4, the interactive

Table 6.5
Cross-country regression for a sample of both developed and developing countries. Dependent variable is growth rate of GDP (1980-1989)

	Full sample			Developed countries			Developing countries		
Eq. No.	1	2	3	4	5	6	7	8	9
Constant	0.001 (1.18)	0.001 (0.927)	0.001 (0.562)	0.005 (0.849)	0.002 (1.35)	0.003 (1.50)	0.002 (1.03)	0.001 (0.976)	0.01 (1.38)
I/Y	0.15^{***} (3.51)	0.15^{***} (3.49)	0.14^{***} (3.42)	0.12^{***} (3.75)	0.12^{***} (3.75)	0.12^{***} (3.73)	0.18^{**} (2.65)	0.18^{**} (2.60)	0.17^{**} (2.60)
$\dot{L}/L$	0.70^{***} (3.29)	0.71^{***} (3.29)	0.68^{***} (3.11)	0.77^{***} (3.11)	0.76^{***} (3.03)	0.73^{***} (2.90)	0.62^{***} (2.76)	0.61^{**} (2.69)	0.61^{**} (2.64)
$(\dot{X})(X/Y)$	0.36^{***} (3.52)	0.38^{***} (3.60)	0.33^{***} (3.45)	0.41^{***} (3.38)	0.44^{***} (3.51)	0.40^{***} (3.34)	0.23^{**} (2.64)	0.25^{***} (2.72)	0.22^{**} (2.58)
HK		0.06^{***} (3.08)	0.04^{***} (2.83)		0.09^{***} (3.76)	0.08^{***} (3.73)		0.04^{**} (2.61)	0.03^{**} (2.56)
INFRA		0.02^{**} (2.62)	0.01^{**} (2.45)		0.05^{***} (2.78)	0.05^{**} (2.66)		0.01^{**} (2.58)	0.008^{**} (2.41)
INTER			0.15^{***} (2.82)			0.19^{***} (3.17)			0.07^{**} (2.48)
R^2	0.60	0.76	0.80	0.68	0.81	0.85	0.53	0.58	0.62
F-value	19.2	25.1	31.0	22.7	26.08	43.1	15.9	13.3	24.1
N	91	91	91	22	22	22	69	69	69

*Note: Here we use Feder's (1983) model. I/Y = GDI/GDP, $\dot{L}/L$ is growth of labour, $\dot{X}/X$ is growth of export, X/Y is ratio of export to GDP, HK is human capital INFRA is infrastructure, and INTER (is the interaction term between exports, and human capital and infrastructure) = $[(\dot{X})(X/Y)]$ * HK* Infra. A separate regression was run using an interaction term between openness parameter and HK, and openness and INFRA separately, but the results are fairly similar. Figures in parentheses are t-values. ***, ** and * denote respectively the 1 percent, 5 percent and 10 percent level of significance*

term between human capital, infrastructure and exports growth is positive although it is only significant in the case of middle-income countries. This seems to suggest that the stock of human capital and quality of infrastructure in low-income countries is not adequate to foster openness.

Tables 6.5 and 6.6 present the regression results for the period 1980-1989. In all regressions the R^2s show that the model is a good fit in explaining the GDP growth. The F-statistics indicate that the explanatory variables are jointly significant. In Table 6.5 the regression results for full sample indicate that I/Y and growth rate of labour have significant contribution to GDP growth. Exports growth holds the expected positive sign and it is significant at 1% level. Moreover, the size of the estimated coefficient of exports growth is much higher in the 1980s than in the 1970s. This seems to suggest that as countries go through some development process (by accumulating human capital and improving the quality of the infrastructure) they tend to benefit more from exports. In column 2 of Table 6.5, after the inclusion of human capital and infrastructure variables the magnitude of the effect of exports has increased by 0.02 points. Furthermore, the impact of human capital and infrastructure seems to be higher in the 1980s than in the 1970s. The interaction term (column 3 of Table 6.5) is positive and significant at 1% level. This again confirms the significant contribution of human capital and infrastructure in determining the effect of exports on growth.

With respect to developed countries the estimated results show that I/Y and growth rate of labour have a significant positive impact on GDP growth. The estimated coefficient of exports growth is also positive and significant at 1% level. It can also be seen that the size of exports growth is greater in the case of developed countries compared to the estimated coefficient for full sample countries. Human capital and infrastructure hold positive coefficients which are statistically significant. Moreover, the magnitude of the contribution of human capital and infrastructure is higher in the 1980s compared to the 1970s. The interactive term (in column 6 of Table 6.5) is positive, while all interacting variables remain positive. This implies that higher level of stock of human capital and infrastructure are positively associated with higher exports growth.

For developing countries the results show that both I/Y and rate of growth of labour have significant contribution to GDP growth. It also shows that the impact of I/Y seems to be higher in the developing countries as compared to developed countries. The estimated coefficient of exports is positive and significant at 5% level, supporting the hypothesis of export-led growth. The variables for human capital and infrastructure continue to show significant positive effect on GDP growth. However, the size of their effect is smaller in the developing countries as compared to developed countries. The interactive term in column 9 of Table 6.5 is positive while the interacting variables are also positive. This implies that the simultaneous increase in human capital, infrastructure and exports have a significant impact on GDP growth.

Table 6.6
Cross-country regression for a sample of Middle-income countries
Dependent variable is growth rate of GDP (1980-1989)

	Middle-income			Low-income		
Eq. No.	1	2	3	4	5	6
Constant	0.001 (1.28)	0.002 (0.907)	0.001 (1.31)	0.11 (1.30)	0.07 (1.46)	0.07 (1.33)
I/Y	0.17^{***} (2.85)	0.16^{***} (2.82)	0.16^{***} (2.82)	0.20^{**} (2.45)	0.20^{**} (2.45)	0.19^{**} (2.41)
$\dot{L}/L$	0.65^{***} (2.81)	0.65^{***} (2.80)	0.65^{***} (2.80)	0.53^{**} (2.61)	0.52^{**} (2.57)	0.52^{**} (2.58)
$(\dot{X})(X/Y)$	0.28^{***} (2.85)	0.31^{***} (2.93)	0.30^{***} (2.89)	0.08 (1.78)	0.11 (1.86)	0.07 (1.75)
HK		0.06^{**} (2.71)	0.04^{**} (2.68)		0.02^{**} (2.42)	0.01^{**} (2.39)
INFRA		0.02^{**} (2.65)	0.01^{**} (2.50)		0.006^{**} (2.47)	0.003^{**} (2.35)
INTER			0.16^{**} (2.67)			0.08 (1.91)
R^2	0.58	0.65	0.72	0.39	0.46	0.50
F-value	18.6	15.1	25.3	7.9	12.1	11.8
N	37	37	37	32	32	32

*Note: Here we use Feder's (1983) model. I/Y = GDI/GDP, $\dot{L}/L$ is growth of labour, $\dot{X}/X$ is growth of export, X/Y is ratio of export to GDP, HK is human capital INFRA is infrastructure, and INTER (is the interaction term between export, and human capital and infrastructure) = $[(\dot{X})(X/Y)]$ * HK* INFRA. A separate regression was run using an interaction term between openness parameter and HK, and openness and INFRA separately, but the results are fairly similar. Figures in parentheses are t-values. ***, ** and * denote respectively the 1 percent, 5 percent and 10 percent level of significance*

Table 6.6 presents regression results for middle- and low-income countries. As can be seen from columns 1 and 4 of Table 6.6, I/Y and growth rate of labour have a significant contribution to GDP growth in both middle- and low-income countries. The estimated coefficient of exports for middle-income countries is positive and significant at 1% level. In the case of low-income countries although it maintains its positive sign it is not statistically significant at conventional levels. As in the case of the 1970s the positive impact of exports on GDP growth is limited to high- and middle-income countries. Human capital and infrastructure have a significant contribution in both middle- and low-income countries, although their magnitude is higher in the middle-income countries. In column 3 and 6 of Table 6.6 the interactive term is positive for both middle- and low-income countries. This implies that the simultaneous increase in human capital stock, quality of infrastructure and exports would increase the absorptive capacity of the countries.

Table 6.7

Cross-country regression for a sample of both developed and developing countries Dependent variable is growth rate of GDP (1990-1999)

	Full sample			Developed countries			Developing countries		
Eq. No.	1	2	3	4	5	6	7	8	9
Constant	0.004 (1.16)	0.01 (1.73)	0.002 (0.108)	0.002 (0.859)	0.003 (1.47)	0.002 (0.118)	-0.05 (-0.098)	0.001 (1.10)	0.006 (0.719)
I/Y	0.15^{***} (2.72)	0.13^{**} (2.67)	0.13^{**} (2.69)	0.11^{***} (3.90)	0.10^{***} (3.85)	0.09^{***} (3.83)	0.18^{**} (2.63)	0.16^{**} (2.60)	0.15^{**} (2.56)
$\dot{L}/L$	0.54^{**} (2.60)	0.55^{**} (2.63)	0.65^{**} (2.64)	0.74^{**} (2.55)	0.73^{**} (2.52)	0.73^{**} (2.51)	0.67^{**} (2.70)	0.66^{**} (2.67)	0.66^{**} (2.67)
$(\dot{X})(X/Y)$	0.42^{***} (4.14)	0.44^{***} (4.26)	0.33^{***} (3.72)	0.39^{***} (3.31)	0.41^{***} (3.37)	0.30^{***} (3.19)	0.16^{**} (2.54)	0.19^{**} (2.62)	0.14^{**} (2.42)
HK		0.05^{***} (2.72)	0.02^{**} (2.55)		0.06^{***} (3.08)	0.04^{***} (2.86)		0.04^{**} (2.49)	0.02^{**} (2.37)
INFRA		0.03^{**} (2.64)	0.009^{**} (2.49)		0.06^{***} (2.92)	0.03^{***} (2.78)		0.01^{**} (2.35)	0.006^{*} (2.22)
INTER			0.13^{**} (2.38)			0.17^{**} (2.63)			0.09^{*} (2.29)
R^2	0.65	0.80	0.88	0.72	0.86	0.93	0.59	0.71	0.73
F-value	15.7	13.9	22.7	18.4	21.7	38.9	10.2	14.7	18.4
N	91	91	91	22	22	22	69	69	69

*Note: I/Y = GDI/GDP, $\dot{L}/L$ is growth of labour, $\dot{X}/X$ is growth of export, X/Y is ratio of export to GDP, HK is human capital, INFRA is infrastructure, and INTER (is the interaction term between export, and human capital and infrastructure) = $[(\dot{X})(X/Y)]$ * HK* INFRA. A separate regression was run using an interaction term between externality parameter and HK only, but the results are fairly similar. . Figures in parentheses are t-values. ***, ** and * denote respectively the 1 percent, 5 percent and 10 percent level of significance*

Nevertheless, its impact is statistically significant only in the case of middle-income countries. This seems to suggest that during the 1980s low-income countries' stock of human capital and quality of infrastructure is not adequate to foster exports.

The regression results for the period of 1990-1999 is presented in Table 6.7 and 6.8. In all regressions the R^2 values for full sample show that good proportion of the variation in the GDP growth is explained by the model. The F-test statistics also show that in all regressions the independent variables are jointly significant. The regression results show that I/Y and growth of labour force have significant contribution to GDP growth. Exports continues to show strong positive impact on GDP growth among sample countries. The estimated coefficient of exports is positive and significant at 1% level. Furthermore, the results show that the magnitude of the impact of exports on GDP growth is larger in the 1990s as compared to the 1980s and 1970s. This seems to suggest that the contribution of exports on growth is greater as the countries go through some development process. When human capital and infrastructure are included in the regression (column 2 of Table 6.7), the size and significance level of the exports increased. In the regression without human capital and infrastructure the coefficient of exports is 0.42 with t-value of 4.14, and following the inclusion of these two variables its coefficient and t-ratio have increased to 0.44 and 4.26, respectively. This confirms earlier findings that human capital and infrastructure play a significant role in the process of growth and making openness beneficial. As can be seen from Table 6.7, the interactive term between human capital, infrastructure and exports is positive and significant at 5% level. Although the significance level is the same as the results for the 1980s, the magnitude of the impact of the interactive term is larger in the 1990s period. This implies that as countries accumulate more stock of human capital and improve the quality of their infrastructure, the contribution of exports tend to increase simultaneously.

With respect to high-income countries the diagnostic tests result show that the model is a good fit in explaining GDP growth. The ratio of investment to GDP and growth of labour force are positive and significant at 5% and 1% levels, respectively. As in the 1980s the results show that the contribution of growth of labour force is greater, but the magnitude is slightly higher in the 1990s. The regression results provide strong evidence that exports is positively associated with GDP growth among high-income countries. The coefficient of human capital and infrastructure are also positive and significant at 5% level. The contribution of human capital seems to be slightly lower in the 1990s than the1980s for high-income countries. This seems to be in line with the idea that the impact of human capital is non-monotonic. INFRA, on the other hand, has greater impact in the 1990s than in the 1980s. Following the inclusion of human capital and infrastructure in the regression, the magnitude and the significance of level of the exports measure has increased, although the effect is not as high as it was in the 1980s.

In the case of developing countries in all the regressions the diagnostic tests indicate that the model is a good fit. I/Y and growth of labour force have positive coefficients, which are significant at 5% level. The contribution of the labour force seems to have decreased in the

Table 6.8

Cross-country regression for a sample of Middle- and Low-income countries. Dependent variable is growth rate of GDP. (1990-1999)

.	Middle-income			Low-income		
	1	2	3	4	5	6
Constant	0.01 (1.69)	0.001 (0.669)	0.001 (0.821)	0.16 (1.43)	0.11 (1.57)	0.05 (1.14)
I/Y	0.16^{**} (2.47)	0.14^{**} (2.41)	0.14^{**} (2.40)	0.19^{**} (2.71)	0.18^{**} (2.67)	0.18 (2.67)
$\dot{L}/L$	0.75^{**} (2.63)	0.70^{**} (2.58)	0.69^{**} (2.55)	0.56^{**} (2.50)	0.54^{**} (2.46)	0.54 (2.48)
$(\dot{X})(X/Y)$	0.27^{***} (3.22)	0.29^{***} (3.31)	0.22^{***} (2.98)	0.13 (1.82)	0.16 (1.94)	0.10 (1.70)
HK		0.06^{**} (2.66)	0.02^{**} (2.48)		0.01^{**} (2.51)	0.02^{*} (2.39)
INFRA		0.04^{**} (2.41)	0.02^{*} (2.30)		0.02^{*} (2.29)	0.009^{*} (2.18)
INTER			0.14^{**} (2.60)			0.005^{*} (2.07)
R^2	0.63	0.78	0.79	0.53	0.61	0.66
F-value	13.1	11.3	19.9	3.6	9.4	13.1
N	37	37	37	32	32	32

*Note: I/Y = GDI/GDP, $\dot{L}/L$ is growth of labour, $\dot{X}/X$ is growth of export, X/Y is ratio of export to GDP, HK is human capital, INFRA is infrastructure, and INTER (is the interaction term between export, human capital and INFRA) = $[(\dot{X})(X/Y)]$ * HK* INFRA. A separate regression was run using an interaction term between externality parameter and HK only, but the results are fairly similar. . Figures in parentheses are t-values. ***, ** and * denote respectively the 1 percent, 5 percent and 10 percent level of significance*

1990s compared to the results for 1980s and 1970s. This could be due to excess supply of the labour force in the 1990s growing at higher rate than the growth or expansion of the economy. The results show that exports is positively associated with GDP growth. When human capital and infrastructure are included in the regression the impact of exports seems to be stronger. Moreover, the interactive term between human capital, infrastructure and exports also have a significant positive effect on GDP growth. Broadly, the impact of exports seems to be larger in the 1990s than the 1980s.

We extend the regression analysis for the period 1990-1999 by dividing developing countries further into middle- and low-income countries. Disaggregating these countries into comparable income groups reveal some interesting and important results. In general, the diagnostic test results for middle-income countries show that the model is a good fit. The coefficients of GDI and growth of labour force are positive and significant at 10% and 5% level, respectively. Exports continue to show a strong impact in the middle-income countries.

It can also be seen that the size of the exports is greater than its size for the full developing countries sample. It also becomes significant at the 1% level, while it is only significant at 5% when the two income groups are mixed together. The coefficient of the interactive term is positive and significant at the 5% level, reaffirming the significant role of human capital and infrastructure in determining the contribution of exports on growth.

In the case of low-income countries the regression results unveil different stories. As can be seen from Table 6.8, the R^2s (in all regressions) are quite small but good enough to shed light in explaining the effect of exports on GDP growth in low-income. The results for the 1990s show that both I/Y and growth of labour force are positive and significant at the 5% level. Exports fails to have a significant impact on GDP growth in low-income countries, although it holds a positive sign. Human capital and infrastructure have positive coefficients and which are statistically significant at the 10% level. Furthermore, the interactive term between human capital, infrastructure and exports also has a positive coefficient but is not significant at conventional levels. As in the case of the 1970s and 1980s the stock of human capital and quality of infrastructure in low-income countries does not seems to high enough to be able to benefit from exports. Although the exports do not have significant contribution in all periods (1970s, 1980s and 1990s), the size and the t-value is higher in the later period. Moreover, when the interactive term is added in the regression for the 1990s, the result shows that the interactive term is positive and significant at 10% level. This shows that as countries go through a development process by accumulating human capital and improving their infrastructure they tend to benefit more from exports. Note here that the interactive term for the 1980s is not significant. It is indeed interesting to note that the positive impact of export on growth appears to be particularly strong for the middle- and high-income countries, but extremely weak and insignificant for the low-income countries.

The estimated results presented in Table 6.7 and 6.12 show no statistically significant link between growth of export and GDP. Unlike in the case of high- and middle-income countries, the interaction term for low-income countries appear to have no significant impact on growth. In the case of low-income countries, although the interaction term is insignificant, both human capital and infrastructure variables seem to have positive impact on growth when they enter into the regression independently. As far as external influences are concerned, then, there is no evidence to support the proposition that the degree of export growth is positively associated with growth performance in low-income countries.

The traditional arguments in aggregate production functions (labour and capital) perform quite differently between the three income groups. The growth rate of labour force is only significant at 10 percent level for the low-income countries, while it is significant at 5 percent level for both high- and middle-income countries. The investment ratio also appear to be significant at 5 percent level for middle- and low-income countries, while it is significant at 1 percent level for high-income countries. As expected, the magnitude of investment ratio is higher in the high-income countries than the middle- and low-income countries.

6.4.2 Panel data analysis

A large number of earlier studies have focused on period averages to examine the impact of exports on economic growth. However, using period averages is likely to hide significant information regarding the changes in individual country economic performance. In the last two decades developing countries have undergone a number of policy reforms including trade policy. Consequently, we employ panel data estimation in this section to extend the analysis of cross-section aspects of the exports -growth nexus.

Unit Root Test

As in Chapter 5, we adopt the Im, Pesaran and Shin (IPS) panel unit root test method and the results are presented in Table 6. The unit root test results show that all variables, with the exception of gGDP and gLAB are non-stationary in levels. For example, I/Y has an average t-ratio of 0.94, which is greater than the critical value -1.85. Therefore, we accept the null hypothesis for a unit root. Similarly, the average t-ratio for HK and INFRA are greater than the critical value, implying a unit root in levels of HK and INFRA. When these variables are differenced once, they all became stationary. For example, when HK is differenced once the average t-ratio became -5.19 which is greater than the critical value. Thus, we reject the null hypothesis for unit root.

Table 6.9

Panel Unit Root Test

		gGDP	I/Y	gLAB	$\dot{X}(X/Y)$	HK	INFRA
All Sample	Levels	-5.19	0.94	-4.83	-1.26	-1.82	2.37
	First difference	-17.4	-6.10	-7.44	-9.07	-5.19	-4.85
Developed Countries	Levels	-13.8	-1.73	-5.91	-1.64	-1.61	2.99
	First difference	-21.4	-6.11	-8.04	-11.30	-7.21	-5.48
Developing Countries	Levels	-8.16	1.66	-4.17	3.19	-1.96	1.69
	First difference	-13.7	-6.42	-10.2	-7.52	-5.01	-4.12

The Regression Results

Tables 6.10-6.11 present regression results that employ the panel data set. In all regressions the Hausman Lagrange multiplier (LM) test indicate that the fixed effect estimator is favourable over the random effect model, and thus we report the fixed effect results. The regression results for full sample countries are presented in Table 6.10. The diagnostic test show that our model is a good fit in explaining the variation in GDP growth. The R^2 are high enough to suggest that the variation in GDP growth is well predicted by the explanatory variables. The F-test statistics show that the independent variables are jointly significant. The White test statistics indicate that there is no heterschedasticity problem in the regression, while the estimated autocorrelation coefficients show that there is no significant autocorrelation problem. The regression results show that I/Y and growth of labour force have significant contribution in the growth of process of GDP. For example, a 1% increase in ratio of investment to GDP would lead GDP growth by 0.16%. With respect to the full sample of countries the regression results show that there is a strong relationship between exports and GDP growth. The estimated coefficient of exports is positive and significant at 1% level. The results also continue to show that human capital and infrastructure have significant role in the process of growth. For example, a 1% increase in the level of INFRA

Table 6.10
Panel regression for a sample high-income countries
Dependent variable growth rate of GDP.(Fixed effect model, 1970-1999)

	Full Sample			Developed Countries			Developing Countries		
	1	2	3	4	5	6	7	8	9
I/Y	0.16*** (2.94)	0.15*** (2.90)	0.13*** (2.85)	0.13*** (3.14)	0.12*** (3.10)	0.12*** (3.09)	0.18*** (2.81)	0.14*** (2.73)	0.14*** (2.74)
$\dot{L}/L$	0.52** (2.61)	0.51** (2.58)	0.50** (2.53)	0.65*** (2.74)	0.62** (2.62)	0.61** (2.58)	0.50** (2.49)	0.48** (2.46)	0.48** (2.46)
$(\dot{X})(X/Y)$	0.35*** (3.34)	0.39*** (3.41)	0.31*** (3.30)	0.42*** (3.47)	0.45*** (3.55)	0.44*** (3.50)	0.16** (2.51)	0.19** (2.59)	0.14** (2.43)
HK		0.07** (2.59)	0.05** (2.45)		0.10*** (2.75)	0.07** (2.61)		0.03** (2.51)	0.01* (2.39)
INFRA		0.04** (2.47)	0.02** (2.33)		0.06** (2.60)	0.03** (2.52)		0.02* (2.36)	0.008* (2.30)
Inter			0.13** (2.54)			0.17*** (3.04)			0.04* (2.28)
R^2	0.70	0.81	0.87	0.78	0.83	0.88	0.66	0.73	0.78
F-value	45.1	56.2	73.4	56.1	52.8	66.1	19.2	41.3	50.8
N	2790	2790	2790	720	720	720	2070	2070	2070
AR	0.039	0.095	0.124	0.018	0.082	0.113	0.060	0.126	0.158
HS	13.9	17.2	21.5	9.55	12.4	14.8	15.7	20.6	24.3

*Note: I/Y = GDI/GDP, $\dot{L}/L$ is growth of labour, $\dot{X}/X$ is growth of export, X/Y is ratio of export to GDP, HK is human capital, INFRA is infrastructure, and INTER (is the interaction term between export, human capital and infrastructure) = $[(\dot{X})(X/Y)]$ * HK* INFRA. A separate regression was run using an interaction term between externality parameter and HK only, but the results are fairly similar. . Figures in parentheses are t-values. ***, ** and * denote respectively the 1 percent, 5 percent and 10 percent level of significance*

would raise GDP growth by 0.04%. After the inclusion of human capital and infrastructure (which enter in the regression as proxies for level of development), the magnitude of openness measure has increased significantly. This shows that the model becomes a better fit in explaining GDP growth and secondly, it that the right effect of exports is reflected. Furthermore, the interactive term (between HK, INFRA and openness variable) is positive and significant at the 5% level. This confirms once more that human capital and infrastructure have an important role in determining the effect of exports on growth. The results in column 3 of Table 6.10 shows that exports is positively associated with the absorptive capacity of the country, as the interactive term is positive and statistically significant.

As in cross-section analysis, we carried out further regressions by dividing the sample of countries into two groups (developed and developing) to examine whether the positive association between exports and growth is confined to certain groups of countries as we have seen in the cross section analysis. With respect to developed countries, the R^2s and F-test statistic show that the model is a good fit in explaining GDP growth in the developed countries. The White test shows that there is no heterschedasticity problem in all regressions. The estimated autocorrelation result indicates that there is no significant autocorrelation problem.

I/Y and growth of labour force hold positive coefficients which are statistically significant at 1%. The regression results provide strong evidence in support of export-oriented policy. That is, the coefficient of exports is positive and significant at the 1% level. In column 5 of Table 6.10 the coefficient of human capital and infrastructure are positive and significant at the 1% and 5% levels, respectively. This confirms again the significant role of human capital and infrastructure in the process of growth. The interactive term, in column 6 of Table 6.10 has positive coefficient which is significant at the 1% level, indicating that the positive association of human capital and infrastructure with higher degree of openness.

Turning to the results for developing countries, the R^2s indicate that the model is a good fit. The F-statistics show that the explanatory variables are jointly significant. The estimated autocorrelation confirms that there is no autocorrelation problem in the regression, while the White test show there is no heteschedasticity problem. The regression results show that I/Y and growth rate of labour have a significant positive contribution to GDP growth. As compared to developed economies, the contribution of I/Y is higher in the developing countries. As noted earlier, this is interpreted in line with the neoclassical growth model that in capital scarce developing countries the rate of return to capital is higher relative to developed countries that possess capital in abundance. The results show that the exports have significant positive impact on GDP growth, supporting the hypothesis of positive externality effect of export in developing countries. Human capital and infrastructure also continue to show significant positive impact on GDP growth. The interactive term between human capital, infrastructure and export is also positive and significant at the 10% level, implying that human capital and infrastructure have significant role in determining the impact of exports on growth.

Table 6.11

Panel regression for a sample Middle and Low-income Countries
Dependent variable growth rate of GDP.
(Fixed effect model, 1970-1999)

	Middle-income			Low-income		
	1	2	3	4	5	6
I/Y	0.17^{**} (2.70)	0.16^{**} (2.67)	0.15^{**} (2.67)	0.19^{***} (2.87)	0.18^{***} (2.79)	0.18^{***} (2.78)
$\dot{L}/L$	0.57^{**} (2.43)	0.57^{**} (2.42)	0.56^{**} (2.38)	0.49^{**} (2.55)	0.48^{**} (2.52)	0.48^{**} (2.51)
$(\dot{X})(X/Y)$	0.23^{**} (2.68)	0.26^{***} (2.74)	0.20^{**} (2.59)	0.07 (1.78)	0.10 (1.86)	0.08 (1.82)
HK		0.06^{**} (2.58)	0.03^{**} (2.47)		0.02^{**} (2.47)	0.008^{*} (2.35)
Infra		0.04^{**} (2.41)	0.02^{*} (2.33)		0.01^{**} (2.32)	0.007^{*} (2.27)
Inter			0.10^{**} (2.49)			0.009 (1.81)
R^2	0.72	0.76	0.80	0.52	0.61	0.67
F-value	39.5	36.1	39.8	16.2	27.3	23.8
N	1110	1110	1110	960	960	960
AR	0.082	0.141	0.173	0.055	0.102	0.124
HS	17.3	19.9	22.5	14.5	25.7	26.1

*Note: I/Y = GDI/GDP, $\dot{L}/L$ is growth of labour, $\dot{X}/X$ is growth of export, X/Y is ratio of export to GDP, HK is human capital, INFRA is infrastructure, and INTER (is the interaction term between export, human capital and infrastructure) = $[(\dot{X})(X/Y)]$ * HK* INFRA. A separate regression was run using an interaction term between externality parameter and HK only, but the results are fairly similar. . Figures in parentheses are t-values. ***, ** and * denote respectively the 1 percent, 5 percent and 10 percent level of significance*

As in the cross-section analysis, we divided developing countries into middle- and low-income to examine whether the results obtained in Table 6.10 holds for the poorer countries with low level of development. The regression results are presented in Table 6.11. With respect to middle-income countries the results all diagnostic test suggest that the model is good fit in explaining GDP growth. The tests suggest that there is no autocorrelation or heteroschedasticity problem in the regression. The regression results show that I/Y and the growth of labour force are positive and significant at 5%. Export seems to have improved significantly compared to the results for the mixed developing countries regression. When the two groups are mixed the size of the coefficient of openness variable is 0.16 (column 7 of Table 6.10), whereas for middle-income countries alone the corresponding figure is 0.23. The interactive term also seems to have higher impact in the middle-income countries compared to the results the whole developing countries. This result shows that mixing sample countries with different stages of development give misleading results usually in favour of relatively higher income groups.

Turning to the results for low-income countries, the R^2 show that a fair proportion of the variation in GDP growth is explained by the model. The F-statistic shows that the independent variables are jointly significant. The estimated autocorrelation suggest that there is no autocorrelation problem. The White test, on the other hand, show that there is no heterschedasticity problem in all regressions. The regression results show that I/Y and labour force have a significant positive impact on GDP growth. As observed in the cross-section regression, the magnitude of I/Y seems to be larger in the low-income countries than high- and middle-income countries. This confirms again the idea that in labour abundant countries the rate of return to capital is higher. Export has a positive coefficient but it is not statistically significant. This provides further evidence that low-income countries are not in a position to benefit from exports. Human capital and infrastructure have significant positive contribution to GDP growth, although the magnitude is low compared to the results for high- and middle-income countries. After the inclusion of human capital and infrastructure variables in the regression, the magnitude and significance level of openness variable has improved but still not statistically significant. Moreover, the interactive term is also positive (though not statistically significant), while the interacting variables remain positive. This implies that low-income countries have to increase the level of the stock of human capital and infrastructure for exports to work in their economy. Based on the results for the interactive term we may interpret as the low level of human capital stock and poor quality of infrastructure in low-income countries is not yet capable to foster exports and benefit from interacting in the world market. In other word, low-income countries do not have the absorptive capacity that will enable them to benefit from exports. It requires them to possess higher level of stock of human capital and quality of infrastructure.

6.5 Conclusions

In this chapter, we adapted Feder's (1983) model to examine the impact of exports on economic growth. We carried out the analysis by using both cross-section and panel data for 86 developed and developing countries over the period 1970-1999. The cross-section regressions are carried out for three decade long averages (1970-1979, 1989-1989 and 1990-

1999), while the panel regression is carried out for the period 1970-1999. As in the previous chapters, we carried out the regressions for the full sample of countries and also separately for the three groups of countries (high-, middle- and low-income). The model states that growth rate of GDP is a function of growth rate of labour, capital (ratio of investment to GDP) and the weighted growth rate of exports (i.e., growth rate of exports multiplied by ratio of exports in GDP).

The cross-section results for the full sample countries indicate that exports make a highly significant contribution to economic growth. This result is consistent with other studies (e.g. Feder, 1983; Kavoussi, 1984; Singer and Gray, 1988, and many others). However, closer observation of the results indicates that the impact of exports is higher in the 1990s than in the 1980s and 1970s. This results provides some evidence that the role of exports in the process of economic growth has become more prominent as globalisation and trade liberalisation are taking place in the eighties and nineties.

We carried out similar regressions for the three groups of countries to examine whether the impact of exports on growth depends on their level of development. We have seen that in the case of high- and middle-income countries exports have significant positive impact on economic growth, while its effect on the growth of low-income countries is statistically insignificant. With respect to high-income countries there is strong evidence that indicate that exports are positively associated with GDP growth in all periods, with its higher effect in the 1990s than that in the 1980s and 1970s, and that it has greater effect in the 1980s than that in the 1970s. In the case of middle-income countries, the contribution of exports to GDP growth is not statistically significant in the 1970s, but it is highly significant in the 1980s and 1990s. In both high- and middle-income countries the magnitude of the impact of exports is increasing as we move from one period to another. For low-income countries, exports do not seem to have significant contribution to economic growth. Indeed, its coefficient is negative in the regression for the 1970s although it is not statistically significant. In the regressions for the 1980s and 1990s exports maintained its positive sign but still not statistically at conventional levels.

We have included the interactive terms between exports, human capital and infrastructure to examine if our level of development indicators (HK and INFRA) play significant role in determining the impact of exports on growth. For all three groups of countries, the interaction term holds positive sign, but it is only significant in the case of high- and middle-income countries. This seems to suggest that human capital stock and quality infrastructure in low-income countries is not adequate for these countries to reap the benefit from export-oriented trade policy.

The panel regression results are consistent with the cross-section results although the size and significance levels are slightly different. The results show that exports are positively associated with economic growth in all groups of countries, although its impact is only statistically significant in the case of high- and middle-income countries.

Here again, the important implication to be drawn from the experience of low-income countries as revealed in the empirical findings of this chapter, is that these countries need to put much greater efforts into raising the level of investment on education and infrastructure rather than simply adopting an outward oriented trade policy. It should be stressed that the results in no way overturn the case for export-led growth. However, the positive externality effect of exporting depends on the absorptive capacity of the country that in turn is determined by the level of human capital and quality of infrastructure. Since export expansion does not seem to affect factor productivity in the primary commodity sector (which is the case in most low-income countries) the results obtained in this study should not be surprising. Primary commodity exports mainly contribute to the GDP growth through their effect on capital formation rather than externality effects. Thus, the externality as well as the productivity effect of exports can only materialise if countries have enough human capital resource and better quality of infrastructure, which determine their absorptive capability.

It is interesting to note here that the positive association between growth of export or share of exports in GDP with economic growth is particularly strong in more developed countries, and does not to exist at all among low-income countries. This seems to suggest that export can only have a positive impact on growth once countries achieve a certain level of development. However, we need to be cautious when interpreting these findings since the proportion of a country's exports may not necessarily reflect its degree of openness. As countries are different with respect to their level of development, they also differ from each other in their export proportion for various reasons (such as size, whether the country is land-locked, proximity to large trading areas, and so on). As noted in the previous chapters, the classification of countries on the basis of their per capita income may be sensitive to alternative method of classification.

CHAPTER 7

Openness and Economic Growth: Causality Test

7.1 Introduction

The theoretical basis for empirical studies on the relationship between export and growth arises both in the neo-classical and endogenous growth models. In the neo-classical growth models, exports generate externality effects as well as increasing the volume and efficiency of domestic production leading to a higher rate of long-term economic growth. On the other hand, the new endogenous growth models consider long-run growth as a function of technological changes, and provide a framework in which export can permanently raise the rate of growth through knowledge spillovers effects. Existing empirical studies on causality between exports and economic growth provide inconclusive results (see Chapter 2 for review of other studies).

Earlier studies, notably those by Jung and Marshall (1987) and Helleiner (1986) cast some doubt on the validity of the export-oriented policy as a strategy for economic growth. These findings tend to contradict other studies which put forward the proposition that exports have a positive impact on economic growth (e.g., Balassa, 1977; Feder, 1983; Greenaway and Sapford, 1994; Bodman, 1996 and others).

Until the mid 1980s, many studies used either a simple bivariate correlation test between export and growth, or a standard production function type of model. Beginning in 1985, researchers carried out causality tests to determine the direction of causality between exports and growth. Using time series data for developing countries, Jung and Marshall (1985) find that in most cases growth of exports does not have causality effect on GDP growth. Chow (1987), on the other hand, finds bi-directional causality between export and growth in eight newly industrial countries (NICs). A number of other studies including Jun and Yu (1996) and Abhayaratne (1996) find that exports and economic performance are independent. Studying the long-run relationship between exports and growth in India, Sinha and Sinha (1996) have found that, although openness and growth are positively cointegrated, they are independent.

The existing studies provide no clear direction of causality between export and growth. While some studies find a uni-directional relationship others find a bi-directional or no relationship at all. Such heterogenous results may be due to different testing techniques used or lag structures specified or to the different filtering procedure employed. In this chapter we attempt to resolve some of the problems by employing the recently developed techniques in causality and cointegration test procedures.

7.2 The Model

7.2.1 Key variables

The model used in this study consists of a four-variable system of real GDP (Y), real exports (X), real imports (M) and net inflows of foreign direct investment (FDI). These variables are then expressed in natural logarithm. Real exports and imports are obtained by deflating their nominal values by the corresponding consumer price index. Although the main focus of this study is to examine the causality effect between growth of exports and GDP, other variables such as imports and FDI are included since they also reflect the degree of openness of the countries.

7.2.2 Vector Autoregressive (VAR) Test

The first technique used in the causality test is based on the following vector autoregressive (VAR) model. In this study we examine causal relationships between four variables – GDP, export, import and FDI. Denote Z as a four-component vector, i.e., $Z=(Y,X,M,FDI)$, where Y, X, M and FDI are at least covariance stationary series. The autoregressive vector (VAR) model can then be written as follows:

$$Z_{it}=\phi_1 Z_{i,t-1}+\phi_2 Z_{i,t-2}+...+\phi_k Z_{i,t-k}+\mu_i+\eta_{it}$$

or

$$\begin{bmatrix} Z_{1t} \\ Z_{2t} \\ Z_{3t} \\ Z_{4t} \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \end{bmatrix} + \begin{bmatrix} \phi_{11}(L) & \phi_{12}(L) & \phi_{13}(L) & \phi_{14}(L) \\ \phi_{21}(L) & \phi_{22}(L) & \phi_{23}(L) & \phi_{24}(L) \\ \phi_{31}(L) & \phi_{32}(L) & \phi_{33}(L) & \phi_{34}(L) \\ \phi_{41}(L) & \phi_{42}(L) & \phi_{43}(L) & \phi_{44}(L) \end{bmatrix} \begin{bmatrix} Z_{1t} \\ Z_{2t} \\ Z_{3t} \\ Z_{4t} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \end{bmatrix} , \quad (7.1)$$

where X_{it} represents the four endogenous variables – GDP, exports, imports and FDI. $\phi_{ij}(L)=\sum_{l=1}^{mij}\phi_{ij,l}L^l$, mij is the degree of the $\phi_{ij}(L)$ polynomial, L is the lag operator such that $L^k W_t = W_{t-k}$, α_{i0} (i=1 to 4) are constants, $\varepsilon_t'=(\varepsilon_{1t},\varepsilon_{2t},\varepsilon_{3t},\varepsilon_{4t})$ is the error term that follow white noise process with zero mean and constant variance which has $E(\varepsilon,\varepsilon_s')=\delta_{ts}\Sigma$, where $\delta_{ts}=1$ if $t=s$, and $\delta_{ts}=0$ if $t\neq s$. Thus, the contemporaneous relationship between the above variables is reflected in the residuals of the model in equation (7.1). The notion of Granger causality in the multivariate models is that X_{jt} Granger causes X_{it} if and only if $\phi_{ij}(L)\neq 0$ (i.e., jointly significantly different from zero), and X_{it} Granger causes X_{jt}, given other variables, if and only if $\phi_{ji}(L)\neq 0$. If X_{it} Granger causes X_{jt}, given other variables, and vice versa then it is said to be a bi-directional (or feedback) relationship between the two variables. Moreover, as Hsiao (1982) noted, if X_{jt} Granger causes X_{kt} and if X_{kt} Granger causes X_{it}, then X_{jt} Granger causes X_{it} indirectly.

7.2.3 Panel unit root test

The conventional Granger causality test requires the variables to follow a stationary process. If the variables are non-stationary the inference drawn from the conventional test is not valid. Before we proceed with the causality test, it is essential to determine the order of integration of each variable. In this chapter we adopt the Im, Pesaran and Shin (IPS, 1998) technique described in Appendix 7. The IPS method allows for heterogeneity in α and γ, and takes the average of the t-statistics obtained from each N independent ADF regressions[1]:

$$\Delta y_{it} = \alpha_i + \gamma_i y_{i,t-1} + \sum_{j=1}^{p} \phi_{ij} \Delta y_{i,t-j} + \beta_i + \varepsilon_{it} \qquad (7.2)$$

for i=1,...,N series, j = 1, ..., p ADF lags, t=1,..., T time period and γ_1= ,..., γ_N= γ. Where Δ is the first order difference operator; y is the variable under consideration, p is the number of lag length of ΔY_{it} needed to achieve white noise residuals. ϕ_i is the estimated vector of coefficients on the augmented lagged differences. The null hypothesis in IPS is $H_0 : \gamma = 0$ for all i, while the alternative is that at least one series has a value of γ significantly less than zero.

IPS proposed two methods of testing for panel unit roots: t-bar statistics and LM-bar statistics. t-bar statistics are constructed by running the standard augmented Dickey-Fuller (ADF) unit root test for each country and averaging the t-values of the test statistics obtained.

To determine the appropriate lag length of each of $\phi_{ij}(L)$ polynomial, we use the sequential procedure proposed by Hsiao (1978, 1981) which is based on the Granger definition of causality and Akaike's minimum final prediction error (FPE) criterion. We start with the highest possible lag order, and sequentially testing down, the optimal lag order, being chosen based on the FPE criterion. This optimal lag order is to be used in the cointegration, vector error correction model (ECM) model and Granger causality tests.

[1] A number of studies employed panel unit root test technique, for example, Macdonald, 1996; Wu, 1997; and Coakley and Fuertes, 1997 adopt the technique proposed by Lin and Levin (1992,1993) to test for purchasing power parity; Culver and Papell (1997) used Quah's (1994) technique to determine the stochastic properties of the inflation rate; and Song-Wu (1998) used the IPS method to examine the hysteresis in unemployment.

7.2.4 Panel cointegration test

In the absence of cointegration we can simply take the first difference of our data and work with the transformed variables. Nevertheless, in the presence of cointegration first differences do not capture the long-run relationships among the variables, and thus the cointegration relationship must be taken into account.

Assuming the possible bi-directional causality between the variables we adopt a panel cointegration test technique proposed by Pedroni (1995, 1997, 1999), which is robust to a causality test in both directions and allows for both heterogeneous cointegrating vectors and short run dynamics across countries. The cointegration estimates takes the following form:

$$X_{it} = \alpha_i + \beta_t + \gamma_i y_{it} + \varepsilon_{it} \quad , \qquad (7.3)$$

where X_{it} represents growth of exports, growth of imports and net flow of foreign direct investment, y_{it} is growth of GDP. In the above formulation (equation 7.3) each country has its own relationship between X_{it} and y_{it} . ε_{it} denotes an error term, α_i is country specific, and β_t is the time specific error term that captures any common global effects that would cause each country variables to move together over time. This could be short-run external effects or long-run changes, such as technological advancement in productivity. The residuals of the above regression is used to construct an ADF based group mean panel cointegration test which is analogous with the ADF unit root test technique of Im, Pesaran and Shin (1998).

7.2.5 Vector error correction model (VECM)

Once a long-run relationship is detected using the cointegration test, it then becomes important to determine the direction of causality. In particular, we are interested in examining if exports are Granger causing output or if the variables cause each other in the long-run. Given the nonstationary nature of the variables under consideration, we test for causality within the framework of a vector-error correction mechanism (VECM). On the basis of the Granger representation theorem Engle and Granger (1987) we can set a system of cointegrated variables in the form of a dynamic VECM model.

There are two steps we need to follow in estimating the VECM model. First, we estimate the long-run relation between GDP, export, import and FDI as formulated in equation 7.1, using the Johansen (1988, 1991) maximum likelihood procedure. Second, we use the estimated cointegrating relationship, to construct the disequilibrium term, $\hat{\varepsilon}_{it} = X_{it} - \hat{\alpha}_i - \hat{\beta}_t - \hat{\gamma}_i y_{it}$, and then we estimate an VECM model for each variable of interest as in the following equations:

$$\Delta y_{it} = c_1 + \lambda_1 \hat{\varepsilon}_{i,t-1} + \sum_{j=1}^{p} \beta_{11,j} \Delta y_{i,t-j} + \sum_{j=0}^{p} \beta_{12} \Delta X_{i,t-j} + \sum_{j=0}^{p} \beta_{13,j} \Delta M_{i,t-j} + \sum_{j=0}^{p} \beta_{14,j} \Delta FDI_{i,t-j} + \upsilon_{1it} \quad (7.4)$$

$$\Delta X_{it} = c_2 + \lambda_2 \hat{\varepsilon}_{i,t-1} + \sum_{j=1}^{p} \beta_{21,j} \Delta X_{i,t-j} + \sum_{j=0}^{p} \beta_{22,j} \Delta y_{i,t-j} + \sum_{j=0}^{p} \beta_{23,j} \Delta M_{i,t-j} \sum_{j=0}^{p} \beta_{24,j} FDI_{i,t-j} + \upsilon_{2it} \quad (7.5)$$

$$\Delta M_{it} = c_3 + \lambda_3 \hat{\varepsilon}_{i,t-1} + \sum_{j=1}^{p} \beta_{31,j} \Delta M_{i,t-j} + \sum_{j=0}^{p} \beta_{32,j} y_{i,t-j} + \sum_{j=0}^{p} \beta_{33,j} \Delta X_{i,t-j} + \sum_{j=0}^{p} \beta_{34,j} \Delta FDI_{i,t-j} + \upsilon_{3it} \quad (7.6)$$

$$\Delta FDI_{it} = c_4 + \lambda_4 \hat{\varepsilon}_{i,t-1} + \sum_{j=1}^{p} \beta_{41,j} \Delta FDI_{i,t-j} + \sum_{j=0}^{p} \beta_{42,j} \Delta y_{i,t-j} + \sum_{j=0}^{p} \beta_{43,j} \Delta X_{i,t-j} \sum_{j=0}^{p} \beta_{44,j} \Delta M_{i,t-j} + \upsilon_{4it} \quad (7.7)$$

The term, $\hat{\varepsilon}_{t-1}$, denotes the previous period disequilibrium, $\hat{\varepsilon}_{t-1} = y_{it-1} - \hat{c}_i - \hat{\alpha} X_{it-1} - \hat{\beta} M_{it-1} - \hat{\delta} FDI_{it-1}$; in the case of cointegrated series at least one of the λ parameters is expected to be significant (this can be considered as alternative for cointegration test). The error term ε_{it-1} represents how far our variables are from the equilibrium relationship and the error correction mechanism estimates how this disequilibrium causes the variables to adjust towards equilibrium in order to keep the long run relationship intact. The Granger representation theorem implies that at least one of the adjustment coefficients $\lambda_{1i}, \lambda_{2i}, \lambda_{3i}, \lambda_{4i}$ must be non-zero if a long run relationship between the variables is to hold.

The fact that we include the estimated error correction term, rather than the true one, does not affect the properties of the estimated coefficients given the consistency feature of the OLS estimator in the cointegration relationships. Note here that in the above ECM model the long-run dynamics are captured by the parameter λ and it is different from the short-run one which is represented by βs.

7.2.5 Ganger causality test

Granger (1969) devised tests to probe into the question whether X causes Y and vice versa. The test makes use of lagged values of Y to explain current Y, and then further to test if lagged values of X can be used to improve the prediction of current Y. In this study, the temporal Granger causality between the variables are examined by applying a joint Wald test to the coefficients of each explanatory variable in the VECM. If the dependent variable is Y, the equation can be represented by:

$$\Delta Y_{it} = \lambda_k V_{k,t-1} + \alpha_1 \Delta Y_{i,t-s} + \alpha_2 \Delta X_{i,t-s} + \alpha_3 \Delta M_{i,t-s} + \alpha_4 FDI_{i,t-s} + \eta_{it} \qquad (7.8)$$

when testing for causality from X to Y, the joint hypothesis is $H_0 : \alpha_2 = ... = \alpha_4 = 0$, which is verified using F-statistics at the 5% significance level.

7.3 Empirical Results

7.3.1 Test results for panel unit roots

The first stage of our work focuses on the analysis of the time series properties of the data. We carry out panel unit root tests for the four variables included in the causality tests. Since we are interested to investigate whether the causality effect of exports on growth varies between countries of different level of development, we carry out panel unit root test for each group. Table 7.1 reports the results obtained applying the IPS unit root test for GDP, exports, imports and FDI. The tests are done both in levels and first differences of the variables.

Table 7.1

Panel Unit Root Tests

	Y	X	M	FDI	ΔY	ΔX	ΔM	ΔFDI
All sample	-1.68	2.52	2.21	1.99	-15.63	-4.81	-8.16	-7.72
High-income	-1.72	1.19	1.55	2.46	-19.80	-6.72	-12.4	-7.50
Middle-income	-0.49	0.82	1.24	2.07	-11.04	-9.21	-14.6	-9.13
Low-income	0.76	1.73	2.67	0.79	-6.44	-3.57	-4.19	-6.51

Note: Δ indicates first order difference. Large negative values indicate stationarity.

The test, based on the average of the standard ADF test, has been calculated independently for each country allowing for up to five lags. Under the null hypothesis of nonstationarity the test is distributed as N(0,1), so that large negative numbers imply stationary.

As can be seen from Table 7.1, the results of the ADF test for each variable show they are integrated of order one since the data appear to be stationary in first differences because the ADF values are rejected against the IPS critical values at 1% significant level.

7.3.2 Test results for cointegration

The cointegration tests are performed in a framework that allows for the highest degree of heterogeneity across countries, and it is computed based on the estimation of the following equation:

$$Y_{it} = c_i + \alpha_i X_{it} + \beta_i M_{it} + \gamma_i FDI_{it} + \varepsilon_{it} \qquad (7.9)$$

Table 7.2 reports the results for the group-ADF statistics along with the panel-ADF test (note here that this test is analogous to that of Levin-Lin unit root test).

Table 7.2

Panel Cointegration Tests

	Panel-ADF statistics					Group-ADF statistics				
	1	2	3	4	5	1	2	3	4	5
All sample	0.07	-0.21	-0.80	-2.17	-4.15	-0.94	-0.12	-1.38	-2.59	-8.69
High-income	-4.16	-4.49	-5.73	-6.91	-9.11	-5.42	-8.16	-8.83	-10.22	-13.18
Middle-income	-2.42	-2.93	-3.86	-4.02	-4.86	-1.85	-2.97	-3.84	-4.09	-5.61
Low-income	0.46	-0.08	-0.39	-1.10	-1.53	0.76	-0.10	-1.42	-2.49	-6.11

Note: The test statistics are distributed as N(0,1) under the null hypothesis of no cointegration.

The tests are computed allowing for up to five years lag length to analyse if the results are consistent with respect to the different dynamic structures. The results suggest that the higher the lag order the stronger the evidence of cointegration. It may worth noting here that the group-ADF statistics are always highly significant, even at lower lags; comparing the results with those for the panel-ADF test it appears that the later may lack power for certain income group, such as low-income countries, for which we would not be able to reject the null hypothesis of no long run relationship if the inference is only based on the panel statistics. The group-ADF test, on the other hand, allows us to reject such a hypothesis for all the estimated low-income panel. This result could be taken as an indicative that there is certain degree of heterogeneity among the sample countries. This finding may well be due to the lack of power of the test, thus, we should be cautious in drawing any inference out of such results. In doing so, we proceed our analysis by employing causality tests.

7.3.3 Test results for vector error correction model (VECM)

Once we detect the presence of cointegration among the four variables (although the cointegration is weaker in the low-income countries panel), it is relevant to test the direction of causality where it exists. The cointegration test gives us an indication about the long-run relationship among the variables. We can then examine the short-run dynamics using the Vector Error Correction Model (VECM). Table 7.3 reports the estimated short-run coefficients obtained using the model described in section 7.2.5. The larger the coefficient is for a variable, the greater the response of the variable to the previous period's deviation. However, if the coefficient is insignificant, the variable is unresponsive to deviation in the equilibrium.

Table 7.3

Results for Vector Error Correction Model Tests

	ΔY		ΔX		ΔM		ΔFDI	
	λ_1	t-test	λ_2	t-test	λ_3	t-test	λ_4	t-test
All sample	-0.22	3.19	-0.08	2.70	-0.06	2.62	-0.007	2.36
High-income	-0.36	5.30	-0.13	4.18	-0.10	4.49	-0.09	3.11
Middle-income	-0.13	2.97	-0.006	2.62	-0.07	2.31	0.008	1.78
Low-income	-0.05	1.84	-.002	2.09	-0.004	2.12	0.0002	0.59

In the case of all sample countries, all variables – growth of GDP, exports, imports and FDI – react negatively, if there is positive deviation from the long run equilibrium. That is, when there is positive deviation from the long-run equilibrium, growth of GDP, exports, imports and FDI will fall. However, if the deviation is negative, all variables will react positively. Since the error correction term (ECT) for growth of GDP is greater, it responds faster than the other variables to the deviations. Since the t-statistics is relatively low for FDI, it can be suggested that it less responsive to deviations.

The results for high-income countries indicate that all variables respond negatively to any deviations in the long-run equilibrium. As in the case of all sample countries, growth of GDP responds faster since the estimated coefficient of ECT for GDP equation is greater than the other variables. In the case of middle-income countries FDI appears to be less responsive to deviations, while GDP, exports and imports respond negatively to deviations in the long-run equilibrium. More interestingly, in the case of low-income, exports and FDI appear to react in the same direction as temporary deviations from long-run equilibrium, although the estimated coefficient of ECT for FDI equation is insignificant. Growth of GDP, on the other hand, reacts negatively to the shocks in the system with highest adjusting speed. Imports appear to unresponsive to deviations in the long run equilibrium.

7.3.4 Results for granger causality test

Turning to the causality issue in more detail, we perform two types of causality test. For each of the variables in the estimated income-grouped countries, we test whether the lagged changes of the other three variables and the error correction adjustment term are jointly equal to zero. This technique amounts to test the hypothesis of no effects, both in the short and in the long run, from the regressors down to the dependent variable. The results of the Granger causality test are presented in Table 7.4a-7.4d.

The results from Table 7.4a indicate that the null hypothesis of no Granger causality from exports to GDP and FDI to GDP can be rejected at 1% significance level, while imports appear to have no causality effect on growth

Table 7.4a

	H_0 :		Wald-test	P-value
All sample	$\Delta X \nrightarrow \Delta Y$	(+)	10.20	0.00
	$\Delta M \nrightarrow \Delta Y$	(+)	1.86	0.26
	$\Delta FDI \nrightarrow \Delta Y$	(+)	4.29	0.01
	$\Delta Y \nrightarrow \Delta X$	(+)	13.51	0.00
	$\Delta M \nrightarrow \Delta X$	(+)	3.12	0.11
	$\Delta FDI \nrightarrow \Delta X$	(+)	2.08	0.15
	$\Delta Y \nrightarrow \Delta M$	(+)	8.14	0.00
	$\Delta X \nrightarrow \Delta M$	(+)	16.22	0.00
	$\Delta FDI \nrightarrow \Delta M$	(+)	11.02	0.00
	$\Delta Y \nrightarrow \Delta FDI$	(+)	1.76	0.31
	$\Delta X \nrightarrow \Delta FDI$	(+)	1.82	0.36
	$\Delta M \nrightarrow \Delta FDI$	(+)	7.59	0.00

Table 7.4b

	H_0 :		Wald-test	P-value
High-income	$\Delta X \nrightarrow \Delta Y$	(+)	16.14	0.00
	$\Delta M \nrightarrow \Delta Y$	(+)	1.67	0.12
	$\Delta FDI \nrightarrow \Delta Y$	(+)	9.04	0.00
	$\Delta Y \nrightarrow \Delta X$	(+)	22.61	0.00
	$\Delta M \nrightarrow \Delta X$	(+)	3.47	0.18
	$\Delta FDI \nrightarrow \Delta X$	(+)	16.4	0.00
	$\Delta Y \nrightarrow \Delta M$	(+)	14.2	0.00
	$\Delta X \nrightarrow \Delta M$	(+)	20.4	0.00
	$\Delta FDI \nrightarrow \Delta M$	(+)	3.05	0.20
	$\Delta Y \nrightarrow \Delta FDI$	(+)	7.16	0.015
	$\Delta X \nrightarrow \Delta FDI$	(+)	2.83	0.19
	$\Delta M \nrightarrow \Delta FDI$	(+)	18.9	0.00

Table 7.4c

	H_0:		Wald-test	P-value
Middle-income	$\Delta X \nrightarrow \Delta Y$	(+)	13.5	0.00
	$\Delta M \nrightarrow \Delta Y$	(+)	0.73	0.72
	$\Delta FDI \nrightarrow \Delta Y$	(+)	9.07	0.00
	$\Delta Y \nrightarrow \Delta X$	(+)	15.2	0.00
	$\Delta M \nrightarrow \Delta X$	(+)	1.27	0.31
	$\Delta FDI \nrightarrow \Delta X$	(+)	11.03	0.00
	$\Delta Y \nrightarrow \Delta M$	(+)	8.43	0.00
	$\Delta X \nrightarrow \Delta M$	(+)	2.09	0.22
	$\Delta FDI \nrightarrow \Delta M$	(+)	1.18	0.28
	$\Delta Y \nrightarrow \Delta FDI$	(+)	5.75	0.11
	$\Delta X \nrightarrow \Delta FDI$	(-)	0.82	0.70
	$\Delta M \nrightarrow \Delta FDI$	(+)	10.7	0.00

Table 7.4d

	H_0:		Wald-test	P-value
Low-income	$\Delta X \nrightarrow \Delta Y$	(-)	7.81	0.01
	$\Delta M \nrightarrow \Delta Y$	(-)	1.04	0.27
	$\Delta FDI \nrightarrow \Delta Y$	(+)	2.17	0.16
	$\Delta Y \nrightarrow \Delta X$	(+)	4.29	0.11
	$\Delta M \nrightarrow \Delta X$	(+)	1.58	0.27
	$\Delta FDI \nrightarrow \Delta X$	(+)	3.11	0.14
	$\Delta Y \nrightarrow \Delta M$	(+)	7.38	0.006
	$\Delta X \nrightarrow \Delta M$	(+)	3.49	0.13
	$\Delta FDI \nrightarrow \Delta M$	(-)	5.36	0.1
	$\Delta Y \nrightarrow \Delta FDI$	(+)	2.19	0.22
	$\Delta X \nrightarrow \Delta FDI$	(+)	5.13	0.09
	$\Delta M \nrightarrow \Delta FDI$	(+)	3.62	0.12

in the case of all sample of countries. GDP, on the other hand, seems to have apositive causality effect on exports, implying that there is a bidirectional causality effect between GDP and exports. Imports appear to have no causality effect on exports, while FDI has a positive effect which is significant at 1 percent level. All (GDP, export and FDI) appear to have a positive causality effect on imports. The estimated Wald test suggests that imports have a positive causality effect on GDP, implying that imports Granger cause GDP through FDI.

In the case of high-income countries the results show that exports and FDI have a positive causality effect on GDP, while imports have no effect at a conventional significance level. GDP and FDI appear to have a positive causality effect on exports, while imports fail to have significant effect. GDP and exports, on the other hand, appear to have positive causality effect on imports at the 1 percent significant level, while the estimated Wald test shows that FDI do not have significant causal effect on imports. GDP, which failed to show a significant causal effect in the case of all sample countries, appear to have positive effect at 5 percent significance level. Exports, on the other hand, do not have any significant causal effect on FDI.

The estimated results for middle-income countries show that exports and FDI have a positive and significant causal effect on GDP, while imports do not. As in the case of high-countries, GDP and FDI appear to Granger cause exports. This shows that there is bi-directional causal relationship between GDP and export. The results show that there is no any causal relationship between exports and imports. Only GDP appear to have positive causal effect on import for middle-income countries. The positive causal effect of imports on FDI indicates that imports Granger causes both GDP and exports through its effect on FDI.

The story of the causal relationship we have seen so far appears to be by far different for low-income countries. For example, both exports and imports seem to have a negative causal effect on GDP, although it is only exports, which are significant at 5 percent level. FDI also failed to have a significant causal effect on GDP as has been observed in the case of high- and middle-income countries. There also seems to be no causal relationship between exports and FDI and imports and FDI. There is, however, a unidirectional causality effect from GDP to imports.

The results suggest that the relation between trade and growth tends to be weak among the poorest countries. These could be due to the fact that these countries are least likely to export (following their comparative advantage argument) the dynamic and highly processed items that would have a greater impact on growth. The results obtained using the simple regression of GDP growth on export suggest that the relationship between exports and growth may not be as strong for low-income countries taken as whole as has been suggested by other studies (e.g. Ram, 1987; Helleiner, 1986).

7.4 Conclusions

This chapter provides further evidence that countries with low stages of development do not seem to benefit from openness. We employed the recently developed techniques for panel data analysis to examine the causality effect between growth of GDP, export, import and FDI. The causality tests are carried out by using error correction mechanism (ECM) and Granger causality test. These tests provide better evidence than a simple correlation test by addressing the direction of causality. We considered a panel of 86 developed and developing countries for the period 1970-1999.

The empirical evidence in this study support the export-led growth hypothesis only in the case of high- and middle-income countries. In the case of high- and middle-income countries we found that there is a bi-directional causality effect between exports and GDP growth, while in low-income countries exports seems to have a negative causality effect on GDP growth although it is not statistically significant. FDI also has a positive causality effect on GDP growth of high- and middle-income countries, while its causality effect is insignificant in the case of low-income countries. Imports, on the other hand, do not have a significant causality effect on GDP growth of all countries.

These findings are in line with the results of the preceding chapters and provide strong evidence, supporting the lack of positive impact of openness in low-income countries. These findings should make policy-makers more cautious concerning the efficacy of trade policies devised to stimulate economic growth by focusing only on the export sector.

These results do not provide a general and strong support for the contention of that GDP growth promotes export growth, particularly at lower levels of development. Although we employed different techniques, data set and time periods the results seem to be similar to those of Jung and Marshall (1985) and Dodaro (1993) who carry out time-series analysis and found insignificant causality effect of exports on GDP growth in most cases of their studies.

Here again we want point out that despite the arbitrary nature of our method of classification of countries, it sheds some light in explaining that the impact of exports does really depend on the countries levels of development.

CHAPETR 8

A Simultaneous Equation Model of International Trade and Economic Growth with Dynamic Simulation

8.1 Introduction

So far we have analysed the impact of openness and exports on economic growth using a single equation model. We have obtained different results for different sets of data depending on whether the countries belong to the high- or low-income group. In Chapter 2 we noted that several empirical studies failed to resolve the controversial findings on the impact of international trade on economic growth. One of the reasons is due to the fact that most of the studies focus only on the partial impact or contribution of trade by using single equation and disregarding the simultaneity relationship between the variables that are associated with trade and growth. In addition, a large number of authors use a single equation model although most of them note the existence of a simultaneous relationship and frequently consider a selected sample of mixed high-income and low-income countries and a selected single hypothesis, such as the impact of export on growth or the contribution of foreign capital flow on domestic saving and investment (see for example, Chenery and Eckstein, 1970; Balassa, 1978; Tyler, 1981; Feder, 1983; Jung and Marshall, 1985).

This chapter attempts to provide a contribution to the analysis of international trade and economic growth by endogenising the basic determinants of GDP growth. We attempt to resolve most of the drawbacks of the earlier studies by developing a simultaneous equation model that captures the relevant contribution of international trade to economic growth.

8.2 The Model

The model consists of six simultaneous equations. The first equation aims at capturing the impact of GDP growth determinants. The second equation incorporates the factors that affect domestic investment, while the third equation posits the determinants of export growth. Factors that influence foreign direct investment (FDI) are included in equation 8.4. Equation 8.5 incorporates factors that determine human capital. Infrastructure determinants are included in equation 8.6. Our analysis includes 86 developed and developing countries for the period 1970-1999. The model is estimated using instrumental variable (3SLS) technique, validated by dynamic simulation.

The simultaneous equation model (SEM) is specified as follows:

$$gGDP_{it} = \alpha_0 + \alpha_1 GDI_{it} + \alpha_2 gLAB_{it} + \alpha_3 gEXP_{it} + \alpha_4 FDI_{it} + \alpha_5 HK_{it} + \alpha_6 INFRA_{it} \quad (8.1)$$

$$GDI_{it} = \beta_0 + \beta_1 GDPPC1_{it} + \beta_2 X_{it} + \beta_3 M_{it} \quad (8.2)$$

$$gEXP_{it} = \gamma_0 + \gamma_1 gGDP_{it} + \gamma_2 TOT_{it} + \gamma_3 TPGDP_{it} + \gamma_4 TOECD_{it} + \gamma_5 XDUTY_{it} + TPTAR_{it} \quad (8.3)$$

$$FDI_{it} = \theta_0 + \theta_1 HK_{it} + \theta_2 INFRA_{it} + \theta_3 INF_{it} + \theta_4 TARIFF_{it} \quad (8.4)$$

$$HK_{it} = \mu_0 + \mu_1 GDPPC_{it} + \mu_2 gPOP_{it} + \mu_3 EDUX_{it} + \mu_4 FEMLIT_{it} \quad (8.5)$$

$$INFRA_{it} = \sigma_0 + \rho_1 gGDP_{it} + \rho_2 GDPPC_{it} \quad (8.6)$$

where $gGDP$ = growth of real GDP

GDI = gross domestic investment as percentage of GDP

$gLAB$ = growth of labour force

$gEXP$ = growth of exports

FDI = ratio of foreign direct investment in GDP

HK = secondary school enrolment

$INFRA$ = telephone line per 1000 inhabitants

$GDPPC1$ = one period lagged real GDP per capita

M = ratio of imports to GDP

X = ratio of exports to GDP

TOT = terms of trade

TPGDP = trade partners' growth of real GDP

TOECD = growth of trade with OECD countries

XDUTY = export duties

INF = rate of inflation

TARIFF = import duties

GDPPC = real GDP per capita

gPOP = rate of growth of population

EDUX = government expenditure on education as percentage of GDP

FEMLIT = female literacy rate

TPTAR = trading partners' tariff rate (weighted average of OECD countries tariff rates).

The model stipulates the impact of openness in the process of economic growth. More specifically, it allows us to examine whether openness to trade is beneficial to high-, middle- and low-income countries. Concurrently associated with the effect of trade in the process of growth is the contribution of both domestic and foreign investment, capital flow, human capital and infrastructure. Such intricately related issues can only be elucidated sufficiently by using a simultaneous equation model of trade and growth.

Equation 8.1 states that growth of GDP is a function of gross domestic investment, growth of labour force, growth of export, foreign direct investment, human capital and infrastructure. The growth of labour and ratio of gross domestic investment in GDP are used as indicators of the two basic factors of production, labour and physical capital. In light of capital scarcity in low-income countries, we expect the contribution of investment may be greater than that in high-income countries. The contribution of labour force, on the other hand, may be greater in the high-income countries than low-income countries. As discussed in Chapter 2, a number of studies have shown the positive impact of growth of exports on GDP growth through various channels. First, growth of exports generate positive externality effects in the economy (i.e. to the import sector as discussed in Feder, 1983 and Chapter 6 of this thesis). Second, exports facilitate conditions for economies of scale to accrue through their effect on resource allocation. That is, movement of resources from less productive traditional sectors to more productive manufacturing sectors. Third, the growth of exports foster international competitiveness which in turn helps to acquire more economically rational production technique and hence increase productivity.

There are two ways through which FDI is assumed to affect economic growth (see de Mello, 1999) for details). First, FDI is expected to be growth enhancing by transferring foreign technology embodied with it to the host country. Second, FDI is assumed to be a vehicle of new ideas from the advanced nations to the LDCs. It thus expected to augment existing stock of knowledge in the recipient country. Therefore, we expect FDI to have a positive sign. The contribution of human capital to economic growth has been a frequent theme in the theoretical and empirical studies (e.g. Lucas, 1988; Grossman and Helpman, 1991; Barro, 1995). The stock of human capital reflects the proportion of the skilled manpower in the economy. Since skilled labour is mainly associated with the industrial productivity, which in turn is a sign of development, a high stock of human capital is assumed to be growth enhancing. Thus, we expect HK to have positive sign.

A number of studies have shown the role of infrastructure in the process of growth (Ratner, 1983; Ascheuer, 1989). And there is some of the empirical literature that provide evidence on the impact of infrastructure on economic growth (Easterly and Rebello, 1993; Barro, 1997; Devarajan, Swanoop and Zov, 1996; Canning, 1999; Canning and Pedroni, 2000). Good quality of infrastructure is assumed to reduce production costs, provide good communication across the countries and allowing expansion of trade between countries, which contributes to higher productivity and hence to growth. Therefore, INFRA is expected to have positive coefficient.

Equation 8.2, hypothesises that investment is determined by the one period lagged value (in levels) of real per capita income, the size of the export sector and the size of the import sector. Researchers have shown that investment in developing countries is restrained by a meagre rate of domestic savings (see for example, Salvatore, 1991). The savings rate, in turn, is assumed to be positively associated with the level of income and the size of the export sector (Mikesell and Zinser, 1973; Hollis, Chenery and Eckstern, 1970; Maizels, 1968; and Lee, 1971). Higher levels of per capita income can then be assumed, *ceteris paribus*, to generate higher rates of savings. Thus, the coefficient of *GDPPC1* is expected to be positive.

As Sprout and Weaver (1993) noted, there are three reasons as to why greater savings are generated in the export sector. First, the more income-concentrated export sector produces a higher propensity to save as compared to the rest of the economy. Second, income generated from the export sector is "administratively and politically easier to tax than more diffused wage or profit income," thus augmenting public savings (Papanek, 1973). Third, a relatively large export sector creates greater incentive to save since the foreign exchange earned from exports can be used for public investment will help to maintain the attraction of foreign investment.

It has been argued that importing (*M*) is one of the sources of investment expansion through its augmenting effect on savings (Salvatore, 1983; Voivodas, 1973; Weisskopf, 1972). Domestic investment in developing countries is constrained by the insufficient level of capital inflows. Citing several empirical findings of (for example, Chenery and Eckstein,1970; Lee 1971; Maizels, 1968; Voivados, 1973; and Weisskopf, 1972) Salvatore (1983) noted that "it has been conclusively confirmed empirically that foreign capital flows, though neutralised by the resulting reduction (in *ceteris paribus* sense) in domestic savings, make a positive net contribution to the rate of capital formation" (pp 70). Thus, we expect the coefficient of import-GDP ratio to be positive.

Equation 8.3 hypothesises that growth of exports depends on growth of GDP (*gGDP*), terms of trade (*TOT*), the economic growth of the main trading partners (*TPGDP*), growth of trade with OECD countries (*TOECD*), duties levied on exports (*XDUTY*) and trading partner's tariff rate (TPTAR). Equation 8.3 posits the determinants of exports growth. The inclusion of growth of GDP variable will provide us results that indicate feedback effect from GDP to export growth. Equation 8.3 is also intended to capture the extent to which the export sector is determined by the internal supply factors (gGDP and XDUTY) as well as external demand forces (TOT, TPGDP,TOECD and TPTAR).

A number of studies have examined the interdependence between growth of GDP and export growth (e.g. Jung and Marshall, 1985; and Chow, 1987). A higher growth rate of output may lead exports to rise given that domestic demand is inadequate to sustain the growth of output. Thus, as much as the growth of export contributes to economic growth, the reverse may also be true. On the basis of this reasoning we expect the coefficient of *gGDP* to be positive. Furthermore, the growth of exports is determined by the country's ability to compete in the world market. The country's ability to compete in international market depends largely on the price of its goods relative to that of the trading partners (*TOT*). Lower prices relative to other competitors may lead to a greater quantity of goods being exported. International markets prices may reflect domestic supply conditions as well as foreign demand. Higher values of the terms of trade indicate greater competitiveness from the trade partners. Thus, we expect terms of trade (*TOT*) to have a positive coefficient.

As Lewis (1970) argues, low demand for developing country's goods in the international market is one of the factors that constrained their economic growth. This gave some basis to researchers and policy makers in the 1970s to suggest import substitution strategy as the best policy instrument for developing countries. Furthermore, a decline in the demand from developed countries for developing countries' products may lead exports to fall. Thus, the economic growth of a country's main trade partner (*TPGDP*) and the increase in trade with OECD countries (*TPOECD*) are expected to have positive coefficients. Export duty, on the other hand, is expected to have adverse effect on the growth of exports. Thus, we expect *XDUTY* to have negative coefficient. The index of tariff rates in principal trading partners (TPTAR) is calculated as the weighted average of OECD countries' tariff rates using real GDP as a weight. When computing TPTAR for OECD country we exclude the tariff rates of that particular country. TPTAR is assumed to be detrimental to growth of exports. Since high tariff rates make imported goods relatively expensive, the demand for foreign goods will fall, which in turn affects growth of exports. Therefore, TPTAR is expected to have a negative coefficient.

Equation 8.4 hypothesises that foreign direct investment (*FDI*) is a function of human capital (*HK*), infrastructure (*INFRA*), inflation (*INF*) and duty on imports (*TARIFF*). Human capital is assumed to reflect the availability of skilled labour force which affects the location decision of foreign investors. A number of studies have provided empirical evidence that suggests a positive impact of human capital on FDI (see for instance, Balasubramanyam et al, 1996; De Mello (1999). Thus, human capital is expected to have a positive relationship with FDI. The number of telephone lines per 1000 inhabitants is used a proxy for infrastructure and communication development. Infrastructure is expected to have a positive impact on FDI as it is assumed that good quality of infrastructure and communication attracts foreign investors. The inflation rate is commonly viewed as an indicator of macroeconomic stability. High inflation rates are considered to reflect weak economic management. Thus, the inflation rate variable (*INF*) is expected to have a negative coefficient. Import duties are assumed to have a negative effect on FDI flow. Most commonly foreign investment may depend on imported goods, which can be capital or intermediate goods. Thus, levying high tariff rates on imported goods *would* have negative effect of FDI.

Equation 8.5 states that human capital is a function of per capita income (*GDPPC*), growth rate of population (*gPOP*), government spending on education (*EDUX*) and female literacy rate (*FEMLIT*). We assume that human capital, which is proxied by the secondary school enrolment, is positively related to income per capita, particularly in developing countries, since a large proportion of population in these countries cannot afford to go to school due their parents' low income. Population growth is assumed to be positively associated with high school enrolment. However, a high rate of population growth must be accompanied with proportional investment on education, which otherwise may have detrimental effect on human capital accumulation as it may affect the number of students enrolled through its effect on shortage of space in schools. In general, we expect population growth to have a positive coefficient. Government spending on education is assumed to have positive impact on schooling, as it is considered to be a good incentive for higher rate of enrolment. We include the female literacy rate in the regression on the basis of the proposition that literate mothers in developing countries tend to send their children to school more than those who never been to school. Thus, the female literacy rate is expected to have a positive coefficient.

Equation 8.6 hypothesises infrastructure as a function of growth of GDP and income per capita. We assume that public investment on infrastructure facilitates better means of communication at a lower cost. Low costs on infrastructure are assumed to lead to expansion of trade and hence generate growth of GDP. Therefore, the growth of GDP is expected to have a positive effect on investment for infrastructure. Since we are using the number of telephone lines per 1000 inhabitants as a proxy for infrastructure, demand for telephone services will increase the number of telephone lines in the country.

Let us summarise the analytical structure of the model. The simultaneity originates in export growth contributing to economic growth in equation 8.1, while export growth itself is being determined by economic growth in equation 8.3. Investment, on the other hand, contributes to economic growth while being determined by one period lagged per capita income in equation 8.2. Furthermore, FDI, human capital and infrastructure are assumed to have positive effects economic growth, while they are being determined by various factors as postulated in equation 8.4, 8.5 and 8.6, respectively. Thus, we hypothesise economic growth to be determined directly by investment, rate of growth of labour force, export growth, FDI, human capital and infrastructure, and indirectly by various determinants of investment, export growth, FDI, human capital and infrastructure.

The above model is estimated by using panel data for 86 developed and developing countries covering the period 1970-1999 (see Appendix 8 for the list). The model is estimated using an instrumental variable (3SLS) technique. As in the case of previous empirical chapters, we divide sample countries into three groups based on their real per capita income in 1995. We expect the impact of trade on growth to differ substantially between the three income groups. Considering the composition of export sector we expect its impact to be larger in high-income countries. Heteroschedasticity of error terms is a common problem with panel data and therefore we have applied the White's heteroschedasticity correction to the t-statistics of the coefficients (White, 1981).

8.3 Unit Root Test Results

We begin the regression analysis by carrying out unit root test to determine the stationarity of the data. We follow the Im, Pesaran and Shin (1998) panel unit root test technique for each of the variables included in the regression (see appendix 3 for details on IPS technique) . This technique involves carrying out a standard augmented Dickey-Fuller unit root test for each country and computing the average of the t-values obtained. Results are presented in Table 8.1.

Table 8.1

Panel Unit Root Test Results

Variables	Average ADF (levels)	Average ADF (first difference)
gGDP	-1.24	-13.8
gLAB	1.16	-6.02
GDI	1.73	-4.19
gEXP	1.24	-6.10
X	-0.82	-8.65
M	1.21	-4.49
HK	-1.30	-11.26
INFRA	3.29	-2.34
FDI	1.84	-3.22
TOT	1.08	-5.31
XDUTY	0.92	-9.19
TPGDP	2.51	-4.38
TOECD	0.73	-6.44
TPTAR	1.20	-8.52
INF	1.47	-9.86
TARIFF	0.89	-6.21
GDPPC	1.53	-8.46
gPOP	-1.07	-7.14
EDUX	2.38	-3.08
FEMLIT	0.74	-6.82

Note: GDI is ratio of gross domestic investment in GDP, HK is ratio of secondary school enrolment to the population of the age group, INFRA is telephone line per 1000 people, FDI is ratio of foreign direct investment in GDP, TOT is terms of trade, XDUTY is export duty, TPTAR is weighted average trading partners' tariff rate, INF is rate of inflation, TARIFF is import duty, GDPPC is GDP per capita, EDUX is ratio of public expenditure on education, and FEMLIT is ratio of female literacy to total female population. The critical values are -2.37 and –2.31 (as tabulated in IPS) to reject the null hypothesis of a unit root at 1% and 5% levels, respectively.

The results for t-bar statistics show that we accept the null hypothesis of non-stationarity for all variables in levels. For example, with respect to GDI we carried out 86 augmented Dickey-Fuller regressions and obtained an average t-value of 1.73. Since the t-ratio is greater than the critical value of -2.37, we accept a unit root for GDI. Similarly, we cannot reject a unit root for each of the remaining variables in levels.

In order to investigate that the variables are I(1), we test for stationarity in first differences, and the results are presented in column 2 of Table 8.1 The results show that in every case we reject a unit root in first differences in favour of stationarity at least at the 5% level. For example, in case of ΔGDI after computing 86 ADF regressions we obtain an average t-value of -4.19, which is less than the critical value of -2.37. Thus, we reject the null hypothesis of nonstationarity for ΔGDI.

8.4 Regression Results

In this section we discuss the results obtained by estimating a model of 6 equations and Tables 8.2 - 8.4 present the regression results. The regression results for the full sample of countries is reported in Table 8.2. The model is estimated using the three stage least squares (3SLS) method, to reduce simultaneity bias. The Hausman specification test confirms that the fixed effect model is statistically preferable to the random or error-components model. The χ^2 statistics of the Hausman specification tests exceed 284.7 in the gGDP equation, 216.1 in the GDI equation, 241.6 in the gEXP equation, 192.7 in the FDI equation, 227.2 in the HK equation and 150.9 in the INFRA equation. The corresponding p-value is less than 0.0001%. The White test accepts the null hypothesis of homoschedasticity of the residuals. The estimated autocorrelation

Table 8.2

Instrumental Variables Estimator (3SLS)
All sample countries (N=2580 (86 countries))
(1970-1999)

REGRESSORS	Equation					
	1	2	3	4	5	6
	gGDP	GDI	gEXP	FDI	HK	INFRA
gGDP			0.21*** (3.17)			0.08** (2.65)
GDI	0.16*** (2.94)					
gLAB	0.53** (2.63)					
gEXP	0.25*** (3.89)					
HK	0.10** (2.62)			0.06*** (3.47)		
FDI	0.03* (2.29)					
INFRA	0.05** (2.48)			0.09*** (2.96)		
GDPPC					0.02*** (3.39)	0.003** (2.52)
GDPPC[-1]		0.17*** (2.74)				
X		0.09** (2.62)				
M		0.07* (2.10)				
TOT			0.02** (2.53)			
TPGDP			0.11* (2.26)			
TOECD			0.15*** (2.83)			
XDUTY			-0.03** (-2.50)			
TPTAR			-0.02*** (-2.76)			
INF				-0.07** (-2.54)		
TARIFF				-0.006*** (-2.81)		
gPOP					0.006 (1.53)	
EDUX					0.08** (2.62)	
FEMLIT					0.001* (2.17)	
R^2	0.65	0.52	0.71	0.55	0.60	0.50
AR	0.1059	0.0982	0.1131	0.1064	0.1119	0.0871
White	18.1	21.7	16.9	29.2	33.4	14.1
Hausman Test	1.68	1.26	1.45	1.22	1.63	1.37
Sargan Test	0.06	0.011	0.01	0.03	0.05	0.002

Note: Figures in parentheses are heteroschedasticity corrected t-values. AR is the estimated autocorrelation coefficient (value ranges between -1 and 1, closer to 0 indicates no autocorrelation problem). White is a test for hetroschedasticity. Hausman Test is the Hausman F-statistic to test for model misspecification. The Sargan statistic tests the validity of the instruments, i.e., the null hypothesis of no correlation between the instruments and the residuals.. Lagged values of explanatory variables are used as instruments in each regression. Figures in parentheses are t-values. •••, •• and • denote respectively the 1 percent, 5 percent and 10 percent level of significance.

coefficient for each regression shows that there is no autocorrelation problem. In all regressions the Sargan test[1] confirms that the model is correctly specified and the instruments used are valid. The estimated coefficients of all variables have the theoretically expected signs.

In equation 1 of Table 8.2 the results show that both labour and capital have significant positive contribution to GDP growth. The rate of growth of labour seems to have greater impact than capital (proxied by the ratio of investment to GDP). The estimated coefficient of export growth is positive and significant at the 1% level, implying that a 1% increase in export growth leads GDP to grow by 0.25%. This indicates that growth of exports are associated with higher growth rate. FDI also has a significant positive effect on economic growth supporting the argument that FDI increases the rate of technical progress and hence productivity. In the gGDP equation the magnitude of the impact of exports is relatively large in both the size and significance level. As expected, human capital and infrastructure have a significant positive effect on GDP growth. This is consistent with the results in the previous chapters.

In equation 2 of Table 8.2, income per capita of the previous period has a positive coefficient which is significant at the 1% level. This supports the argument that income per capita affects investment through its effect on domestic savings. As noted earlier, this is based on the assumption that current investment is determined by the savings in the previous period. As expected the ratio of export to GDP has a positive coefficient which is significant at the 5% level, supporting the view that the export sector has greater impact on savings and hence investment as compared to the rest of the economy. A 1% increase in the ratio of exports to GDP would stimulate the ratio of investment to GDP by about 0.09%. Capital inflows, as proxied by the ratio of imports in GDP, is

[1] Note here that since Limdep V.7 does not report the Sargan's test, to test the validity of the instruments we estimate the residuals (obtained from the simultaneous equation regression) on the instruments and use the F-test to determine for their validity (see Sargan, 1958 for details).

positively associated with investment, and statistically significant at the 10% level.

In equation 3 growth of GDP has a positive and highly significant effect on the growth of exports. This indicates that there is a bi-directional impact between the growth of export and GDP growth. However, the contribution of growth of GDP to export growth seems to be greater than the effect of growth of export on GDP growth. In equation 1 of Table 8.2 a 1% rise in export growth would stimulate growth of GDP by 0.25%, whereas a 1% increase in GDP growth (in equation 3 of Table 8.2) would lead export growth by 0.21%. This may be considered as an indication that a higher growth rate of output (or productivity) enhances opening up to international trade, or the other way around. It can also be suggested here that since the impact of GDP growth outweighs the effect of growth of export, it is GDP growth that leads to higher rate of growth of export. The terms of trade variable has a positive coefficient, which is significant at the 5% level, implying that a 1% increase in terms of trade leads export to grow by 0.02%. As noted earlier the lower a country's export price relative its trading partner's price the more price competitive it will be and consequently it will achieve a higher rate of export growth.

The variable for GDP growth of trading partners is positive and significant at the 10% level. This supports the idea that the increase in trading partner's income leads to a greater quantity of goods exported. The estimated coefficient of the growth rate of trade with OECD countries shows that it has a significant positive impact on the growth of exports. This seems to suggest that the increase in the demand from the OECD countries for both OECD and non-OECD countries has a significant impact in the growth of exports. As expected, export duties have a detrimental effect on the growth of exports, implying that a 1% cut in export duty would lead to export growth of 0.03%. Finally, the trading partner's tariff rate variable (proxied by the weighted average tariff rates of OECD countries) is negative and significant at the 5% level. This shows that tariff rates of other countries is one of the detrimental factors in the growth of exports. Higher tariff rates make imported goods more expensive, which in turn forces demand for imported goods to fall. Consequently, the growth of exports will be hampered.

8.3.1 Differences due to stages of development

In this section we discuss the regression results we obtained by estimating the models for different income groups. This is aimed at examining if trade restrictions operate differently for countries with contrasting levels of development. We divide our sample into three sub-groups, namely, low-, middle- and high-income countries based on their per capita income in 1995 (see appendix 8 for list) as per World Bank classification.

Results for High-income countries

The results for high-income countries show that the fixed effect model is statistically preferable to the random or error-components model as indicated by the Hausman specification test. The χ^2 statistics of the Hausman specification tests exceed 431.8 in the gGDP equation, 292.85 in the GDI equation, 410.5 in the gEXP equation, 347.2 in the FDI equation, 471.4 in the HK equation and 374.5 in the INFRA equation. The corresponding p-value is less than 0.0001%. The White test accepts the null hypothesis of homoschedasticity. The estimated autocorrelation for each regression shows that there is no autocorrelation problem. In all regressions the Sargan test indicates that the model is correctly specified and the instrumental variables are valid instruments.

The regression results for high-income countries show that all estimated coefficients have the predicted sign and most of them are statistically significant at better than the 5% level. In equation 1 of Table 8.3, the estimated coefficient of investment is positive and significant at the 5% level. Not surprisingly, the size of the coefficient (0.64) of growth rate of labour indicates that its contribution is greater than the effect of capital (as proxied by ratio of investment in GDP). This supports the notion that in high-income countries where labour force is scarce, the rate of return to labour is much higher than capital. The results show that a 1% growth in labour force would lead to GDP growth of 0.64%, whereas a 1% increase in ratio of investment to GDP would enhance GDP growth by only 0.12%.

As expected, growth of exports has a highly significant contribution to GDP growth. This implies that exports for high-income countries plays important role in GDP growth. The stock of human capital is also positively associated with the growth of GDP. The estimated coefficient of FDI is positive and significant at the 1% level. It is not surprising to observe a positive contribution of FDI in high-income countries that are well endowed with human capital good quality of infrastructure, which is imperative for FDI flows. Infrastructure also has a positive coefficient which is statistically significant at the 5% level. This suggest that better means of communication have a significant role in the process of GDP growth.

In equation 2 of Table 8.3, all the diagnostic tests show that the model is a goods fit in explaining the ratio of investment to GDP. The estimated coefficient for GDPPC[-1] is positive and significant at the 1% level, implying that savings from the previous period are positively associated with current investment. The estimated coefficient of the ratio of exports to GDP is positive and significant at the 1% level. This indicates that the export sector has a significant contribution to the domestic investment. The ratio of imports in GDP, which enters in the regression as a proxy for capital inflow, shows that it does not have significant contribution to investment in the high-income countries. This could be due to the fact that imported goods in the high-income

Table 8.3
Instrumental Variables estimator (3SLS)
High-income countries (N=660 (22 countries))
(1970-1999)

REGRESSORS	Equation					
	1	2	3	4	5	6
	gGDP	GDI	gEXP	FDI	HK	INFRA
gGDP			0.26*** (2.85)			0.12* (2.18)
GDI	0.12** (2.62)					
gLAB	0.64*** (2.79)					
gEXP	0.39*** (5.18)					
HK	0.08** (2.54)			0.09*** (3.76)		
FDI/GDP	0.09*** (2.83)					
INFRA	0.06** (2.69)			0.11*** (3.17)		
GDPPC					0.0002** (2.35)	0.009*** (2.71)
GDPPC[-1]		0.23*** (3.40)				
X		0.14*** (2.82)				
M		0.05* (2.27)				
TOT			0.01* (2.15)			
TPGDP			0.13*** (2.75)			
TOECD			0.17*** (4.08)			
XDUTY			-0.05*** (-2.79)			
TPTAR			-0.08*** (-3.16)			
INF				-0.003* (-2.38)		
TARIFF				-0.03*** (-2.97)		
gPOP					0.002* (2.17)	
EDUX					0.03** (2.51)	
FEMLIT					0.0003 (0.528)	
R^2	0.69	0.60	0.79	0.63	0.52	0.58
AR	0.1201	0.1035	0.1013	0.1125	0.1056	0.0489
White Test	286 .3	175.6	331.8	152.6	186.3	94.2
Hausman Test	1.09	1.51	1.42	1.28	1.56	1.16
Sargan Test	0.006	0.03	0.017	0.002	0.004	0.004

*Note: Figures in parentheses are heteroschedasticity corrected t-values. AR is the estimated autocorrelation coefficient (value ranges between -1 and 1, closer to 0 indicates no autocorrelation problem). White Test is a test for hetroschedasticity. Hausman Test is the Hausman F-statistic to test for model misspecification. The Sargan statistic tests the validity of the instruments, i.e., the null hypothesis of no correlation between the instruments and the residuals. Lagged values of the explanatory variables are used as instruments in each regression. Figures in parentheses are t-values. *** , ** and * denote respectively the 1 percent, 5 percent and 10 percent level of significance.*

countries are dominated by primary and consumer goods, which do not have a direct contribution to investment.

In equation 3 of Table 8.3, GDP growth has a highly significant feedback effect on growth of exports. However, we need to point out that the contribution of the growth of exports to GDP growth is greater than the contribution of GDP growth to growth of exports. The estimated coefficient of TOT is positive and significant at the 10% level. The results show that trading partners' GDP growth has a positive contribution to the growth of export in high-income countries. This seems to suggest that the trading partners' GDP growth leads to increase demand for high-income countries' products. The coefficient of TOECD is positive and significant at the 1% level, implying that a higher growth rate of trade with OECD countries is associated with growth of exports among high-income countries. As expected, duties on exports have a negative coefficient, which is statistically significant at the 1% level. The results show that the trading partners' tariff (TPTAR) also has significant adverse effect on the growth of exports of high-income countries.

The results in equation 4 of Table 8.3 show that human capital and infrastructure have a significant impact on FDI. But equation 1 shows that these variables also affect the growth of GDP in the high-income countries directly. Therefore, from equation 1 and 4, we note that human capital and infrastructure affect GDP growth both directly and indirectly through FDI. It may be noted that the impact of human capital and infrastructure is greater on FDI (as in equation 4) than gGDP (as in equation 1). Inflation, which enters in the regression as a proxy for macroeconomic stability, has a significant negative impact of FDI. Import duty also has a negative coefficient, which is significant at the 1% level, implying that high tariff rates are detrimental to the flow of foreign investment.

In equation 5 of Table 8.3, income per capita seems to be positively associated with human capital, although its impact seems to be very low. The coefficient of gPOP is positive and statistically significant at the 10% level. That is, growth of population in high-income countries has a significant positive impact on the rise of the stock of human capital. The result shows that the ratio of government expenditure on education to GDP (EDUX) has a highly significant positive effect on human capital. For example, a 1% increase in government spending on education would stimulate human capital to rise by 0.03%. The coefficient of FEMLIT is positive but not statistically significant.

In equation 6 of Table 8.3, the results show that growth of GDP has a positive impact on infrastructure. Although the significance level seems to be low (only at the 10% level), the size of the coefficient indicates that growth of GDP has a high influence on the quality of infrastructure. The coefficient of GDPPC is positive and significant at the 1% level, implying that higher income per capita determines the demand for greater communication services.

Results for Middle-income countries

Turning to the results for middle-income countries, the R^2s show that a fair proportion of sample variations in the dependent variables can be explained by the regressors. The White test does not reject the null hypothesis for homoschedasticity. The estimated autocorrelation also shows that there is no significant autocorrelation problem. The Sargan test confirms the validity of instruments used in each regression.

In equation 1 of Table 8.4, capital and labour have a positive coefficient, which are significant at the 1%. Growth of export also seems to have a significant contribution to GDP growth. The result indicates that a 1% growth of export would lead GDP growth by 0.15%. Human capital also holds the expected positive sign and it is significant at the 1% level, implying that higher

Table 8.4

Instrumental Variables estimator (3SLS)
Middle-income countries (N=1050 (35 countries))
(1970-1999)

REGRESSORS	Equation					
	1	2	3	4	5	6
	GDP	GDI	gEXP	FDI	HK	INFRA
gGDP			0.24^{***} (2.81)			0.05^{**} (2.49)
GDI	0.17^{***} (2.90)					
gLAB	0.42^{***} (2.75)					
gEXP	0.15^{***} (3.43)					
FDI	0.04^{*} (2.35)					
HK	0.12^{***} (2.83)			0.06^{***} (2.79)		
INFRA	0.05^{**} (2.42)			0.07^{***} (2.81)		
GDPPC					0.007^{***} (2.75)	0.001^{*} (2.14)
GDPPC[-1]		0.14^{**} (2.60)				
X		0.08^{**} (2.58)				
M		0.11^{*} (2.19)				
TOT			0.05^{***} (2.79)			
TPGDP			0.08^{**} (2.50)			
TOECD			0.06^{**} (2.61)			
XDUTY			-0.02^{**} (-2.55)			
TPTAR			-0.005^{*} (-2.37)			
INF				-0.08^{**} (-2.66)		
TARIFF				-0.004^{**} (-2.59)		
gPOP					0.01 (1.27)	
EDUX					0.09^{***} (2.70)	
FEMLIT					0.003^{**} (2.63)	
R^2	0.62	0.45	0.67	0.57	0.53	0.44
AR	0.1004	0.1015	0.1107	0.0951	0.1066	0.0972
White	17.5	11.3	19.3	12.6	17.5	11.5
Hausman Test	1.72	1.86	1.64	1.51	1.73	1.46
Sargan Test	0.02	0.0114	0.03	0.01	0.03	0.005

*Note: Figures in parentheses are heteroschedasticity corrected t-values. AR is the estimated autocorrelation coefficient (value ranges between -1 and 1, closer to 0 indicates no autocorrelation problem). White is a test for hetroschedasticity. Hausman Test is the Hausman F-statistic to test for model misspecification. The Sargan statistic tests the validity of the instruments, i.e., the null hypothesis of no correlation between the instruments and the residuals. Lagged values of explanatory variables are used as instruments in each regression. Figures in parentheses are t-values. *** , ** and * denote respectively the 1 percent, 5 percent and 10 percent level of significance* stock of human capital is positively associated with a higher rate of growth of GDP.

The coefficient of FDI is positive and statistically significant at the 10% level. This supports the notion that FDI flow stimulates growth through its effect on the recipient country's productivity by introducing new ideas and improving management skills. The result also shows that infrastructure has a significant contribution to GDP growth. In equation 2 of Table 8.4, one period lagged income per capita has a significant impact on the current investment. As noted earlier this is mainly through its effect on the previous period savings that is assumed to be used for current investment. The coefficient of ratio of exports to GDP is positive and significant at the 5% level. The results show that the ratio of import to GDP has a significant positive impact on investment. This seems to suggest that imports (which we assume are primarily capital goods in the case of middle-income countries) are positively associated with a higher ratio of investment in GDP.

In equation 3 of Table 8.4, the estimated results show that GDP growth has a highly significant positive impact on the growth of export. This shows that there is feedback effect of gGDP on the growth of exports. Here again, the contribution of gGDP to growth of exports is greater than the effect of gEXP on gGDP (as given by equation 1). That is, a 1% increase in GDP growth enhances export growth by 0.24%, while a 1% export growth leads to only 0.15% growth of GDP. The coefficient of TOT is positive and statistically significant at the 1% level, implying that price competitiveness in the world market has a positive effect on the growth of exports among the middle-income countries. The estimated coefficient of TPGDP is positive and significant at the 5% level. This indicates that the growth of trading partner's GDP leads to an increase in the demand for middle-income countries' products. Growth of trade with OECD countries also seems to have a high contribution in the growth of export. The estimated result shows that a 1% increase in trade with OECD countries would enhance export growth by 0.06%. This seems to suggest that a large proportion of export from middle-income countries is to OECD countries, and thus the increase in trade with these countries would contribute to higher growth of exports. As expected, export duty has a negative coefficient, which is statistically significant at the 5% level. This implies that high export duties have an indirect detrimental effect on GDP growth through its adverse effect on growth of exports. The coefficient of TPTAR is negative and significant at the 5% level, implying that exports of middle-income countries are highly sensitive to changes in tariff rates of their trading partners.

In equation 4 of Table 8.4 (FDI), the results show that the stock of human capital is positively associated with FDI. That is, a 1% rise in the stock of human capital would enhance a 0.06% rise in FDI. As noted earlier, human capital plays significant role in attracting foreign investment. The coefficient of infrastructure is also positive and significant at the 1% level, once more supporting the idea of the important role infrastructure plays in determining the location of FDI. Inflation, on the other hand, seems to have significant adverse effect on the flow of foreign investment. Since inflation is assumed to reflect macroeconomic instability, a high inflation rate can be considered as indicative of economic mismanagement affecting the flow of foreign investment. The estimated coefficient of tariff is negative and statistically significant at the 5% level. As we noted earlier, higher tariff rates have an impeding effect on the inflow of capital as well as intermediate goods, which most foreign investors would like to use in the host country.

In equation 5 of Table 8.4, the results indicate that income per capita has a significant contribution to the increase stock of human capital. This suggests that schooling in the middle-income countries is partially depend on the parent's income. The growth of population also seems to be positively associated with the stock of human capital, though not statistically significant at any conventional level. The coefficient of EDUX is positive and significant at the 1% level, implying that government spending on education is positively associated with a higher level of stock of human capital. It is assumed that high government spending on education would increase the number of schools and quality of education. The results show that the female literacy rate has a significant effect on human capital. This indicates that in the middle-income countries literate mothers tend to send their children to school more than the illiterate mothers.

In equation 6 of Table 8.4, GDP growth seems to have a highly significant contribution to the level of infrastructure. That is, a 1% growth of GDP would lead INFRA to rise by 0.05%. The coefficient of GDPPC is also positive and significant at 10% level. This implies that the demand for infrastructure is determined by consumers' income.

Results for Low-income countries

The Hausman specification test confirms that the fixed effect model is statistically preferable to the random or error-components model. The White test accepts the null hypothesis of homoschedasticity of the residuals. The estimated autocorrelation for each regression shows that there is no autocorrelation problem. In all regressions the Sargan test confirms that the model is correctly specified and the instruments used are valid.

The regression results for low-income countries reveal a wholly different story. In equation 1 of Table 8.5, the ratio of investment to GDP and labour have positive coefficients, which are significant at the 1% and 5% levels, respectively. Export growth also seems to be positively associated with GDP growth. However, its contribution is not statistically significant at conventional levels. This is in line with earlier findings that exports do not have a significant impact on growth among low-income countries. This is primarily due to the lack of sufficient human capital that would enable them to absorb ew ideas from advanced nations through their interaction in the world market.

Table 8.5
Instrumental Variables estimator (3SLS)
Low-income countries (N=870 (29 countries))
(1970-1999)

REGRESSORS	Equation					
	1	2	3	4	5	6
	gGDP	GDI	gEXP	FDI	HK	INFRA
gGDP			0.19*** (2.73)			0.03* (2.35)
GDI	0.21*** (3.25)					
gLAB	0.47** (2.40)					
EXPORT	0.09 (1.83)					
FDI	0.003 (0.773)					
HK	0.05* (2.36)			0.03** (2.51)		
INFRA	0.01* (2.27)			0.05** (2.67)		
GDPPC					0.04*** (3.60)	0.001 (1.86)
GDPPC[-1]		0.09 (1.91)				
X		0.04* (2.17)				
M		0.08** (2.64)				
TOT			0.02 (1.72)			
TPGDP			0.001 (0.861)			
TOECD			0.13*** (2.79)			
XDUTY			-0.006 (-1.58)			
TPTAR			-0.04** (-2.67)			
INF				-0.05** (-2.42)		
TARIFF				-0.002 (-1.60)		
gPOP					0.001 (0.627)	
EDUX					0.04** (2.59)	
FEMLIT					0.003** (2.65)	
R^2	0.47	0.40	0.51	0.43	0.64	0.41
AR	0.0873	0.0957	0.0844	0.1136	0.0971	0.0850
White	17.4	12.4	16.8	10.7	13.1	9.1
Hausman Test	1.26	1.51	1.38	1.82	1.67	1.25
Sargan Test	0.03	0.006	0.07	0.03	0.07	0.004

*Note: Figures in parentheses are heteroschedasticity corrected t-values. AR is the estimated autocorrelation coefficient (value ranges between 0 and 1, closer to 0 indicates no autocorrelation problem). White is a test for hetroschedasticity. Hausman Test is the Hausman F-statistic to test for model misspecification. The Sargan statistic tests the validity of the instruments, i.e., the null hypothesis of no correlation between the instruments and the residuals. Lagged values of explanatory variables are used as instruments in each regression. Figures in parentheses are t-values. ***, ** and * denote respectively the 1 percent, 5 percent and 10 percent level of significance*

FDI seems to be positively associated with GDP growth, though not statistically significant. The results show that infrastructure has a significant contribution to GDP growth.

In equation 2 of Table 8.5, the results show that GDPPC(-1) has a highly significant impact on investment. This strengthens the idea that past savings (which determined by the level of income per capita) have a positive impact on current investment. The coefficient of the ratio of exports to GDP is positive and significant at the 10% level. Capital inflow, proxied by ratio of imports to GDP, has a positive coefficient, which is significant at the 5% level. This indicates that imports (primarily capital goods in low-income countries) have a positive contribution to domestic investment.

In equation 3 of Table 8.5, gGDP has a positive coefficient, which is significant at the 5% level. This indicates that GDP growth, other things equal, is a primary force for the growth of exports in low-income countries. Terms of trade also have significant positive effect on the growth of exports. Since low-income countries exports are dominated by primary goods, their competitiveness in the world market is mainly between themselves. Thus, the positive impact of TOT should be interpreted cautiously by considering the composition of their exports. The coefficient of TPGDP is positive but not statistically significant. This shows that the growth of exports in low-income countries is not sensitive to changes in the trading partners' GDP. This is not surprising in view of the well-known fact that the elasticity of primary exports with respect to income of the industrialised countries is less than unity. More interestingly, the growth of trade with OECD countries has a significant impact on the growth of exports of low-income countries. This seems to suggest that OECD countries are major trading partners of low-income countries, thus the removal of any trade barrier with these countries would lead exports of low-income countries to increase. The estimated coefficient of XDUTY is negative, but it is not statistically significant. Trading partners' tariff rate (proxied by the weighted average of OECD countries tariff rates) seems to have a significant adverse effect on the growth of exports among low-income countries. This indicates that high tariff rates levied by their trading partners (primarily OECD countries) restrain the growth of exports from the low-income countries.

In equation 4 of Table 8.5, the results show that human capital is positively associated with FDI, supporting the idea that human capital plays a significant role in determining the flow of foreign investment. Infrastructure also has an important influence in the location of FDI, as the estimated coefficient of INFRA is positive and significant at the 5% level. The coefficient of inflation is negative and significant at the 5% level. This implies that macroeconomic instability is one of the impeding factors on FDI flows. Tariff seems to be negatively associated with FDI, though not statistically significant. This seems to suggest that tariffs are not the main determining factor in low-income countries.

The coefficient of income per capita is positive and significant at the 1% level (equation 5 of Table 8.5), implying that schooling in low-income countries is heavily determined by the parents' income. Population growth holds a positive coefficient, although it is not statistically significant. This could be due to the disproportionate growth of population with the expansion of schools. The coefficient of EDUX is positive and significant at the 5% level. The results indicate that a 1% increase in public spending on education would lead to 0.04% increase in the stock of human capital. The coefficient of FEMLIT is positive and statistically significant at the 5% level. As we noted earlier, this seems to suggest that in low-income countries literate women (mothers) tend to send their children to school more than illiterate mothers.

Infrastructure in low-income countries seems to be highly determined by the growth of GDP (equation 6 of Table 8.5). As the results show, a 1% growth of GDP would lead infrastructure to rise by 0.03%. The coefficient of GDPPC is positive, but not statistically significant at conventional levels. This can be interpreted as the number of telephone lines in low-income countries is not primarily determined by the income of the inhabitants.

Comparative analysis between the three groups of countries

The most salient but not surprising result is that the disparities in the size of the export coefficient between the three income groups. In the case of high-income countries to a 1% percent increase in exports is associated with a 0.39% increase in economic growth. The comparative figures for middle- and low-income countries are 0.15% and 0.09%, respectively. However, the t-values are significant only in the case of high- and middle-income countries. This means that the significant contribution of exports growth is limited to high- and middle-income countries.

The growth rate of labour in equation 1 (GDP equation) has a significant positive impact on growth in all income groups, supporting the theoretical framework of the neoclassical growth model. As in the case of the growth of exports, the magnitude of the estimated coefficients varies very significantly across the three income groups with highest for high-income countries (0.64) and the lowest for low-income countries (0.47). It can also be suggested here that for high-income countries the degree of the impact of labour is relatively larger than the rest of GDP determinants in the regressions. This can be considered as an indication that the rate of return to labour is higher in high-income countries than low- and middle-income countries. This could be due the fact that labour is scarce in high-income countries, and thus its rate of return will be higher compared to low-income countries where labour is available in abundance.

The results show that the positive contribution of the ratio of investment to GDP growth is higher in low-income countries than the other two income groups. For low-income countries a 1% increase in domestic investment as a share of GDP is associated with 0.21% rise in GDP growth. The comparative figures for high- and middle-income countries are 0.12% and 0.17%, respectively. This implies that low-income countries are relatively more labour abundant than the other two income groups, thus the rate of return on capital is much higher in low-income countries than high- and middle-income countries, which are more capital abundant.

The other interesting result in equation 2 is that the positive and statistically significant import-GDP relationship observed in all countries, but the effect seems to be higher in middle-income countries with the estimated coefficient of 0.11, while for high- and low-income countries the comparative figures are 0.05 and 0.08, respectively. Middle-income countries seem to benefit more from imports than high- and low-income countries. Per capita income appears to have a significant positive impact on investment in all income groups. The magnitude, however, is less consistent as the coefficient is higher for middle-income countries than low- and high-income countries. The ratio of export has a positive contribution to the ratio of investment in GDP for all countries.

In equation 3 the results show that economic growth has a significant positive role in the growth of exports, implying a feedback effect by GDP growth in high- and middle-income countries. We need to point out here that, in the low- and middle-income countries the effect of economic growth on export is larger as compared to that of growth of export on GDP growth. In the low-income countries a 1% growth of exports would lead to GDP growth by 0.09%. The comparative figures for high- and middle-income countries are 0.39% and 0.15%, respectively. On the other hand, a 1% growth of gGDP would lead to growth of export by 0.19% in low-income, and 0.24% in middle-income and 0.26% in high-income countries.

The terms of trade have a positive significant effect on exports growth in all income groups, with its highest impact in the high-income countries. As noted earlier, the terms of trade reflect price competitiveness of a country in the world market, thus it is not surprising to find the highest positive impact of TOT in the high-income countries as they have relatively more stable exchange rate and price level than either middle- or low-income countries.

The estimated coefficient for the growth of trading partner's GDP (TPGDP) is positive for all income countries. However, it is only statistically significant for high- and middle-income countries. As we noted earlier, this due to the fact that primary good exports of low-income countries have low income elasticities.

The result indicates that growth in trade with OECD countries contributes significantly to exports growth, though the results are mixed. Low-income countries seem to benefit more than the middle-income countries by trading with OECD countries. In low-income countries a 1% increase in trade with OECD countries induces exports to grow by 0.13%. The comparative figures for high- and middle-income countries are 0.17% and 0.06%, respectively. Export duties hold the expected negative sign in all income groups and they all are statistically significant. In addition, the results show that the negative impact of export duties is larger in high-income countries. That is, for high-income countries a 1% rise in export duties will have a 0.05% adverse effect on export growth, whereas in middle- and low-income countries the corresponding figures are 0.02% and 0.006%, respectively. This implies that in low-income countries the growth of exports is determined largely by poor productivity efficiency and a lack of adequate demand for their products but not by the duties levied on their exports.[2] The results show that trading partner's tariff rates have substantial impact on the growth of low-income countries, even higher than that on the middle-income countries. If low-income countries get a 1% tariff reduction from their trading partners (here proxied by OECD countries' tariff rate) their export would grow by 0.04%. The comparative figures for high- and middle-income countries are 0.08% and 0.01%, respectively.

In equation 4, we find consistent and credible results that support the positive impact of human capital and infrastructure on FDI in all income groups. However, their impact is greater among high-income countries. For instance, in high-income countries a 1% increase in the stock of human capital will enhance FDI to grow by 0.09%. The corresponding figures for middle- and low-income countries are 0.06% and 0.03%, respectively. In general, the results suggest that human capital and infrastructure have a positive contribution to economic growth both directly and indirectly through their effect on FDI. We also have to add here that besides skilled labour force (human capital) better means of communication plays a significant role in attracting FDI flows and hence in the process of economic growth.

The results indicate that inflation is negatively associated with FDI in all income groups. The effect seems to be more pronounced in the middle-income countries as the size (with the coefficient of -0.08) is larger than the results for high- and low-income countries with estimated coefficients of -0.003 and -0.05, respectively. The impact of tariffs on FDI seems to be less consistent among different income countries. In all cases tariffs appear to have a negative impact on FDI, but its significant influence is confined among high- and middle-income countries. Tariffs seem to have least effect on FDI in low-income countries, as the estimated coefficient is not significant at conventional levels. This indicates that tariffs are not the major determining factor for FDI in the low-income countries. The indirect negative effect of tariffs (through FDI)

[2] Note here that in most countries, developed or developing, export duty figures are not as high as tariff rates. Even in some low-income countries we may find as low as 0.07% (in the case of Bangladesh)

on growth seems to be negligible. Human capital and infrastructure, on the other hand, contribute significantly in determining the level of FDI in all income groups. This supports our argument that human capital and the quality of infrastructure determine the location of FDI.

In equation 5 there is a consistent positive impact of income per capita on human capital in all income groups. However, the effect seems to be greater in the case of low-income countries. This could be due to the fact that in high-income countries and most middle-income countries do not depend on the parents' income since education is efficiently subsidised by governments of these countries. Population growth also seems to have a positive contribution to the stock of human capital. However, population growth is statistically significant at the 10% level only in high-income countries, while it is insignificant in middle- and low-income countries. Therefore, it appears that in middle- and low-income countries the increase in population size or the demand for education does not match the supply (due to low rate of expansion of schools).

The results show that public spending on education seems to have a significant contribution in increasing the stock of human capital, although the relationship is mixed. The effect seems to be higher among the middle-income countries. A 1% increase in public spending for education leads the stock of human capital to increase by 0.09%. The comparative figures for high- and low-income countries are 0.03% and 0.04%, respectively. These results suggest that some economies like middle- and low-income countries need to put more funds into education to accumulate high level of human capital, which in turn increases the rate of economic growth.

We find less consistent results regarding the positive impact of the female literacy rate. Although it maintains its positive sign in all income

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exports duty.

groups, it only appears to be significant among middle- and low-income countries at the 1% level. This may be due to the fact that in such economies where illiteracy is concentrated in the female population, literate mothers are believed to send their children to school. In high-income countries where the illiteracy rate is negligible, if there is any, the contribution of female literacy rate does not seem to have significant impact on the stock of human capital.

The results show that GDP growth has a significant effect on infrastructure in all countries, although its impact seems to be larger in high-income countries. Per capita GDP, on the other hand, seems to be positively associated with infrastructure in all countries, but its impact is statistically significant only in high- and middle-income countries.

8.5 Dynamic Simulation

In this section we take the analysis one step further by considering the dynamic simulation model[3]. By using the estimated parameters, the initial values of endogenous variables (i.e. base year values), and time series for the exogenous variables the model yield simulated values for each of endogenous variables. Table 8.5 presents historical and simulated values for the endogenous variables. As can be seen from the table the stimulated values are quite close to the average historical values. Taken all income categories together, the divergence of the stimulated value from the actual value in *gGDP*, *FDI* and *HK* is less than 1.5%, while for *GDI* and *gX* it is around 0.07%. The root-mean-square-errors (RMSE) statistics show that the model is a good fit, implying how close the simulated values are to actual values (see Appendix 12 for details on RMSE).

Although the cross-section regressions generate average long-run growth estimates, they also measure the short-run variations in the endogenous variable (*gGDP*, *GDI*, *gX*, *FDI* and *HK*). We employ Theil's inequality coefficient (T) and the decomposition into proportions of inequality (Appendix 13 for details): bias (T^B), variance (T^V) and covariance (T^C).

Table 8.6

Actual and Simulated Average Annual Values, 1970-1999

	High-income					Middle-income					Low-income				
	gGDP	*gX*	*GDI*	*FDI*	*HK*	*gGDP*	*gX*	*GDI*	*FDI*	*HK*	*gGDP*	*gX*	*GDI*	*FDI*	*HK*
Historical	2.98	6.72	49.6	37.3	97.7	3.57	11.6	31.5	19.3	54.9	2.2	5.7	20.6	10.3	29.4
Model	2.85	6.69	49.4	36.01	96.2	3.43	11.3	31.1	18.1	53.5	1.7	5.5	20.2	9.5	28.2
RMSE	0.02	0.04	0.01	0.01	0.02	0.03	0.02	0.05	0.02	0.01	0.02	0.02	0.03	0.02	0.01

Table 8.7

Theil's Inequality Coefficients and their Decomposition

	High-income					Middle-income					Low-income				
	gGDP	*gX*	*GDI*	*FDI*	*HK*	*gGDP*	*gX*	*GDI*	*FDI*	*HK*	*gGDP*	*gX*	*GDI*	*FDI*	*HK*
T	0.34	0.18	0.22	0.27	0.19	0.29	0.21	0.27	0.39	0.20	0.24	0.38	0.21	043	0.29
T^B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
T^V	0.11	0.27	0.15	0.36	0.07	0.47	0.36	0.29	0.44	0.18	0.61	0.66	0.35	0.30	0.11
T^C	0.37	0.54	0.42	0.69	0.32	0.47	0.49	0.88	0.75	0.49	0.59	0.70	0.83	0.86	0.67

Table 8.6 presents the computed Theil's inequality and it decomposition. The results for Theil's inequality suggest that in the case of low-income countries at least 75% of actual short-run intercountry variations in *gGDP* were predicted by the model, and the corresponding figures for middle- and high-income countries are 71% and 66%, respectively. In all income groups more than 70% of the variation of GDI is predicted. In the case of high-

[3] Here simulation is the mathematical solution of a simultaneous set of difference equations that relates the current value of one variable to current and past values of other variables (see Black and Bradley, 1990; or Chiang, 1984 for details on differenced equation).

income countries more than 88% of the variation were predicted while for middle-income countries it is 73% and 79% for low-income countries (Appendix 14 presents simulated figures).

For high-income countries more than 75% of variation in FDI were predicted, while 61% for middle-income, and 57% for low-income countries. Finally, the results indicate that in all income groups more than 70% of HK variation was predicted. The results show that for all income groups there is no part of the error that is biased in all endogenous variables. The values of the variance also indicate that, on average, the model was able to replicate the degree of variability in all income groups. There is, however, a large proportion of the error, which is due to the imperfect covariance. Nevertheless, it is unreasonable to expect predictions that are perfectly correlated with actual values, thus the imperfect values of covariance is less worrisome. These indicate that the model performed well in predicting the actual values of the endogenous variables.

8.6 Conclusions

This chapter has employed a simultaneous equation model to analyse salient quantitative features of international trade and economic growth. The model has six endogenous variables; namely, GDP growth (gGDP), the ratio of investment to GDP (GDI), rate of growth of exports (gEXP), the ratio of foreign direct investment to GDP (FDI), human capital (HK) and infrastructure (INFRA). The first equation states that GDP growth is determined by the growth of labour, the ratio of investment in GDP, the growth of exports, the ratio of foreign direct investment in GDP, human capital and infrastructure. The second equation aims at capturing the factors that affect domestic investment, and states that GDI a function of one period lagged per capita income, the ratio of exports in GDP and the ratio of imports in GDP. The third equation posits the determinants of exports growth and it assumed to be a function of GDP growth, terms of trade, trade partner's GDP growth, growth of trade with OECD countries, export duties and trade partner's tariff rate. The fourth equation incorporates factors that determine FDI, assumed to be a function of human capital, infrastructure, rate of inflation and import duties. The fifth equation states that human capital is a function of GDP per capita, growth rate of population, the ratio of public expenditure on education to GDP and the ratio of female literacy rate. Finally, in equation six, infrastructure is given as a function of GDP growth and per capita income. In this model trade and trade-related variables will affect GDP growth both directly and indirectly through the endogenous variables. For example, exports will have an effect on GDP growth both directly and indirectly through its effect on GDI. On the other hand, TARIFF will affect GDP growth through its effect on FDI.

The model resolves the simultaneity bias problem arising from the endogeniety nature of some of the explanatory variables. Many earlier studies analysed the impact of trade and trade policy on economic growth by using a single equation model, such as the GDP growth equation, although many of them admit there will be simultaneity bias in their models. The model was estimated by instrumental variable technique, validated by the dynamic simulation. We tested the model using a panel of 86 developed and developing countries for the period 1970-1999. We developed the model by incorporating and synthesising earlier partial works related to trade and growth.

We began the analysis by estimating the model for the full the sample of countries, and then proceeded to examine whether the results obtained for the full sample of countries hold for different groups of countries that differ in their level of development. For the full sample of countries, there is strong evidence that indicates exports and FDI have a significant impact on GDP growth. Trade policy variables (XDUTY and TARIFF) also have a significant indirect impact on GDP growth through their effect on exports and FDI, respectively. We have also seen that tariffs levied by the countries trading partners have an adverse effect on the growth of their exports and hence on GDP growth. Furthermore, the results show that increasing trade with OECD countries has a significant effect on GDP growth through its effect on the growth of exports. The general implication of the results is that openness is positively associated with the growth of the economy. It is also revealed that human capital and infrastructure make a significant contribution to GDP growth both directly and indirectly through their effect on FDI.

As noted earlier we carried out further regressions to examine whether the results obtained for full sample countries hold for different groups of countries. The impact of trade and trade-related variables on economic growth in high-, middle- and low-income countries is estimated by considering both direct and indirect effects. The effect of export growth varies widely among the three groups of countries with different level of development. The significant positive impact of exports on economic growth appeared to be limited to high- and middle-income countries. Although gEXP has a positive sign in all regressions, it is only statistically significant in the case of high- and middle-income countries. FDI also seems to make a significant contribution in high- and middle-income countries, but not in low-income countries. XDUTY is negatively associated with GDP growth through its effect on growth of exports in all groups of countries, although it is only statistically significant in the case of high- and middle-income countries. Similarly, TARIFF seems to have significant adverse effect on FDI and hence on GDP growth in high- and middle-income countries, while its negative effect is statistically insignificant in low-income countries. The findings in this chapter are consistent with the results in Chapter 4-7, and seem to suggest that the impact of openness on economic growth depends on the level of development of the countries.

In all regressions HK and INFRA appeared to make a positive contribution to the growth process of the economy. They affect GDP growth both directly and indirectly through FDI. We have also seen that in all groups of countries trade with OECD countries has a significant impact on GDP growth through its effect on growth of exports. On the other hand, trade partners' tariff rate (as proxied by the weighted average tariff rates of OECD countries) has adverse effect on growth of exports and hence on GDP growth. In addition, macroeconomic instability (as proxied by inflation) also has significant negative effect on FDI and hence on GDP growth.

Overall the results are consistent with the findings in the earlier chapters that low-income countries with a low level of development do not seem to benefit from openness. Although the export growth variable has a positive sign in all regressions, its statistically insignificant effect in low-income countries supports the view that trade may not be an engine of growth in poor countries with relatively low stock of human capital and poor quality of infrastructure.

While the impact of openness does not seem to exist among low-income countries, its impact is quite large and significant in high- and middle-income countries. Unlike many other empirical studies we attempted to resolve the problem of simultaneity bias in GDP growth equation. Although the results might be sensitive to the alternative method of classification of the countries, it sheds some light on how openness operates differently in the countries that differ with respect to their human capital endowment and quality of infrastructure.

CHAPTER 9

Summary and Conclusions

9.1 Context

During the last fifty years, the relationship between international trade and economic growth has been a topic of sustained interest and controversy in the trade and development literature. Several studies would suggest that free trade is an important part of policy reform in developing countries. A number of studies attempted to examine the link between trade, trade policies and economic growth measured in terms of productivity or per capita GDP. The inherent issue is whether the main sources of growth in less developed countries come from external sources (i.e., through international trade) or internal sources (i.e., through human capital and physical capital accumulation). The rapid economic growth of the East Asian countries is usually cited as a success story of export-led growth (rapid increase in proportion of their exports in GDP). Some authors, on the other hand, argue that the interventionist approach by the governments (through industrial and human development policy) of the East Asian countries played an important role in creating stable economic condition for long run economic growth (Wade, 1990; Amsden, 1989).

Several theoretical studies have shown that international trade plays a significant role in the process of technological transfer from advanced countries to less developed countries (e.g. Grossman and Helpman, 1991; Rivera-Batiz and Romer, 1991a, 1991b). It has also been suggested that technologically less advanced nations tend to grow faster than technologically advanced countries. Despite a number of theoretical and empirical studies employing different analytical models that explain the impact of openness on economic growth, there are still considerable controversies that need to be resolved.

Chapters 2 and 3 present surveys of the theoretical and empirical literature on the relationship between trade and growth. We have seen that there is considerable disagreement among researchers concerning the impact of international trade on economic growth. At this stage, we agree with the view of Rodriguez and Rodrik (2000) that currently available empirical studies do not provide strong evidence about the relationship between trade and growth. Most of the cross-country empirical studies consider mixed samples of developed and developing countries, which give biased results usually in favour of high-income countries.

As discussed in Chapter 3, some studies found strong evidence in support of outward-orientation hypothesis (e.g. Feder, 1983; Harrison, 1996; Edwards, 1992, 1998 and many others), while some obtained results that indicate no significant correlation between openness and economic growth (e.g. Michaely, 1977; Helleiner, 1986). Furthermore, Rodriguez and Rodrik (1999) tested the robustness of several empirical studies and considered that the findings in these studies are fragile as the results are sensitive to alterations in the econometric specifications. Resolving the controversy surrounding international trade and economic growth would help less developed countries to formulate appropriate trade policies that would induce economic growth.

In order to resolve such controversy we begin our analysis by suggesting that developing countries, in order to benefit available technology from developed nations, need to attain well-developed absorptive capacity, which, in turn, is determined by the endowment human capital and quality of infrastructure. We argue that openness by itself is not an economic factor that would generate economic growth. It is rather a mechanism that would enable economic factors to improve their productivity. In this study we examine what prevents developing countries from adopting newly developed technologies. Using a wide range of trade and trade related variables, we have tested whether openness operates differently in countries that differ in their levels of development.

This thesis attempts to resolve a few controversial empirical findings by providing robust empirical results applicable to various groups of countries depending on their level of development. More specifically, we have divided countries into three groups based on their real income per capita, and run different regressions for each group. This thesis provides an empirical analysis of the impact of openness and trade liberalisation on economic growth. The basic hypothesis of our research is that countries differ in their capacity to absorb foreign technology. One implication of this hypothesis is that an increase in human capital and improvement in the quality of infrastructure raises the overall absorptive capacity so that the benefits of openness will lead to higher economic growth. This proposition is supported by the empirical findings presented in Chapters 4-8.

Most of the earlier studies focused on finding a positive correlation between openness and economic growth. In this study we attempt to investigate what limits countries from successfully adopting new ideas. We have examined whether openness is a sufficient condition for low-income countries to attain higher rates of growth. Our analysis shows that openness is a necessary but not a sufficient condition for low-income countries. In other words, we argue that a country's absorptive capacity will determine the success of free trade policy in low-income countries.

We have employed various methodologies to investigate empirically the impact of openness on economic growth, and also to determine robustness and consistency of our results. We have considered human capital and infrastructure as proxy components of a country's absorptive capacity and tested their significant role in the process of economic growth using both cross-section and panel data set. We have also included the interactive terms between human capital, infrastructure and openness variables to examine complementarity effects between free trade and absorptive capacity.

9.2 Principal Findings

9.2.1 Summary of results in Chapter 4

In Chapter 4 we have extended Edwards' (1998) empirical work and examined the impact of openness on total factor productivity (TFP) growth. TFP growth in this model are Solow-type of residuals obtained by estimating GDP growth on the growth of labour and capital by using panel data set for 91 countries over the period 1960-1990. We then took a decade-long average for 1980-1990 to carry out a cross-section regression using six [SW (the binary index developed by Sachs and Warner, 1995), WDR (the World Bank's subjective classification of trade regime in World Development Report, 1987), Leamer (openness index developed by Edward Leamer, 1988 using average residuals from the regressions of trade flows), BMP (average black market premium), TARIFF (average duties on imports) and CTR (the ratio of total revenues on trade taxes to total trade)].

For the full sample of countries (that include both developed and developing countries) the results support the hypothesis that the more open economies tend to grow faster than those who are less open to trade. With the exception of Leamer, the remaining five openness indicators hold the expected signs and they all are statistically significant at the conventional levels. To test whether the results obtained for the full sample of countries hold for the samples of different groups of countries that differ in their levels of development, we carried out similar regressions for each group (high-, middle- and low-income) of countries. Note here that these countries are divided in to three groups on the basis of their per capita income.

With respect to high- and middle-income countries the results show that openness has a significant impact on TFP growth, although the magnitude seems to be more pronounced in the high-income countries. For example, for high-income countries the coefficient of TARIFF is -0.04 with a t-value of -2.61, while for middle-income countries the comparative figures are -0.0007 and -2.07. For low-income countries, on the other hand, the positive effect of openness is very weak or non-existent. Out of six openness measures only one (BMP) has the expected sign and is statistically significant. More interestingly, two of trade policy variables (TARIFF and CTR) have positive sign and they are statistically significant. It may be noted here that import duties and tax on international trade make a significant contribution to the total revenue of low-income countries. It seems reasonable to assume that the revenue is used for public investment purposes so that tariff and trade taxes show positive impact on TFP growth.

Following the theoretical model of Lahiri and Raimondos-Moller (1997), we carried out further regression analysis to examine the effect on TFP growth of foreign aid (AID) when interacting with TARIFF and CTR. We find that the coefficient of the interactive terms (TARIFF*AID) and (CTR*AID) are negative and significant while the coefficients of AID, TARIFF and CTR are positive. These results may be interpreted in the following way. An increase in foreign aid (which is mainly development aid) is associated with a reduction in tariffs and taxes on international trade. This implies that a cut in tariff rates in low-income countries should be accompanied by an increase in aid.

Furthermore, in all regressions, human capital and infrastructure variables are positive and statistically significant at the conventional levels, although their impact is greater in high-income countries both in terms of their size and significance level. More importantly, following the inclusion of these variables the size and significance of openness variables in most cases have improved. This reflects the significant role of human capital and infrastructure both directly and indirectly through the openness variables.

The empirical findings in this chapter infer that the impact of openness on productivity growth is limited to high- and middle-income countries, implying that countries can only benefit from openness once they achieve a significant level of development in terms of human capital and infrastructure. We have also seen that human capital and infrastructure make a significant contribution to TFP growth in all groups of countries. This seems to suggest that low-income countries have more to do with their human resource development and improving the quality of infrastructure than being constantly preoccupied by the degree of openness to trade.

9.2.2 Summary of results in Chapter 5

Chapter 5 extends the empirical analysis presented in Chapter 4 first by using a panel data set, second by adding two more openness variables [TRADE (ratio of export + import to GDP) and DISTORT ($1+t_m/1-t_x$, where t_m is duties on imports and t_x is duties on exports). However, because of the lack of time-series data for Leamer and WDR, we could not include these variables in the analysis. As in Chapter 4, we began the analysis by running a panel regression of GDP growth on the growth of labour and capital, and then take the residuals as TFP growth.

For the full sample of 86 countries, the results continue to show that openness is positively associated with productivity growth during 1970-1999. All openness indicators hold the expected signs and they are significant at the conventional levels. We then carried out separate regressions for the periods 1970-1979, 1980-1989 and 1990-1999. In all regressions the results show that openness has significant impact on TFP growth. However, the results for different periods show that the magnitude of the impact of openness is greater in the 1990s than that in the 1980s, and again in the 1980s is greater than that in the 1970s. These results seem to suggest that more open economies tend to grow faster than those who pursue inward-looking trade policy. Nevertheless, when we divided the sample countries in to three groups (high-, middle- and low-income) we found results that indicate the limitations of the above suggestion. The results reveal that the positive and significant impact of openness is confined to high- and middle-income countries only.

With respect to high-income countries there is strong evidence for the positive association of openness with productivity growth. All openness variables hold the expected signs and they are highly significant. The results for different periods show that although openness seems to have positive impact in all periods its effect is higher in the 1990s than that in the 1980s and 1970s. We have also seen the estimated coefficient for the initial level of per capita income is negative and highly significant, implying that significant convergence is taking place among high-income countries.

In the middle-income countries, the results for the period 1970-1999 show that openness has positive impact on TFP growth. Nevertheless, the results for different periods reveal a different story. In the 1970s, only three (BMP, CTR and DISTORT) are statistically significant, while in the 1980s with the exception of SW the rest of openness variables are significant, and in the 1990s all openness variables are statistically significant. The estimated coefficient of initial level of per capita income indicates that significant convergence is taking place in middle-income countries. However, the small values of the coefficients seem to indicate that the convergence process is very slow.

With respect to low-income countries, openness does not seem to have a significant impact on TFP growth. Three of the trade policy variables (TARIFF, CTR and DISTORT) possess the unexpected (positive) sign and they are significant at conventional levels. BMP is the only trade-related variable that holds the expected sign and statistically significant. The results for the 1970s show that with the exception of SW and BMP, the remaining four trade and trade-related variables (TRADE, TARIFF, CTR and DISTORT) hold the unexpected signs and three (TARIFF, CTR and DISTORT) are statistically significant. In the 1980s and 1990s TRADE maintains its positive sign, although it is not statistically significant. TARIFF, CTR and DISTORT, on the other hand, continue to have a positive sign in the regressions for the 1980s and 1990s. Moreover, the regression results for various time periods show that the size of the estimated coefficients of TARIFF, CTR and DITORT are larger in the 1970s as compared to those in the 1980s and 1990s. BMP is the only trade-related variable that shows little change in its impact in different periods. The estimated value for the initial level of per capita income (GDP70) shows that significant convergence is not taking place among low-income countries.

We have carried out further analysis to find an appropriate explanation for the positive impact of TARIFF, CTR and DISTORT. Two basic issues that are related to low-income countries are tested: (1) the role of foreign aid (AID) in the growth process of low-income countries. We also tested the interaction effect of AID with trade barriers (TARIFF, CTR and DISTORT) as postulated by Lahiri and Raimondos-Moller (1997). (2) We tested whether import substitution is an alternative strategy for low-income countries. This is tested by including IND (the ratio of industrial output in GDP) – which is a proxy for import substitution strategy - and the interactive term between IND and TARIFF in the regression. We have obtained results that show foreign aid makes a significant contribution to TFP growth. On the other hand, the interactive terms [(AID*TARIFF) (AID*CTR), and (AID*DISTORT)] has negative coefficients which are statistically significant, implying that the increase in foreign aid is associated with a decrease in trade barriers. This seems to suggest that low-income countries need more foreign aid (particularly that would help them to build their absorptive capacity) to be able to reduce trade barriers and hence reap benefit from openness. Although openness does not seem to work for low-income countries at this stage, one possible alternative explanation for the positive sign of TARIFF, CTR and DISTORT is import substitution industrialisation. Our results show that an import-substitution strategy is not an alternative explanation. The interactive term between TARIFF and IND (ratio of industrial output in GDP) is negative and statistically significant, implying that higher tariff rate is negatively associated with industrial output.

The estimated results for the interactive terms between the human capital, infrastructure and openness variables seem to suggest that the role of trade and trade policy measures is determined by the country's level of development. The level of stock of human capital and quality of infrastructure plays a significant role in determining the impact of openness on TFP growth. The overall implication of the results for low-income countries is that at the current state of development, they need to focus more on capacity building than reforming trade policy.

9.2.3 Summary of results in Chapter 6

Chapter 6 attempts to estimate the impact of exports on economic growth and presents cross-country regressions for the period 1970-1979, 1980-1989 and 1990-1999 and panel regressions for the period 1970-1999 for a sample of 86 countries. We have adopted Feder's (1983) model, which states GDP growth is determined by the growth of labour, ratio of investment in GDP and the product of growth of exports and ratio of exports in GDP. The estimated results for the full sample countries provide some evidence in support of export-oriented trade policy. As indicated in the general framework, a higher growth rate of export and ratio of export to GDP, has a positive impact on GDP growth both directly and indirectly through its externality effect on the non-export sector. However, it is clear that the magnitude of the impact of growth of exports on GDP growth is larger in the 1990s as compared to that in the 1980s, and the same in the 1980s is greater than that in the 1970s. This seems to suggest that as countries go through the dynamic process of economic development (in terms of accumulation of human capital and improving quality of infrastructure) exports begin to exert a greater effect on GDP growth. When the sample countries are divided into different groups based on their per capita income the positive contribution of exports to GDP growth seems to be limited to high- and middle-income countries.

With respect to high-income countries the results show that exports have significant impact on GDP growth in all periods, although its impact seems to be higher in the 1990s than that in the 1980s and 1970s. In the middle-income countries the positive contribution of exports is only statistically significant in the 1980s and 1990s but not in the 1970s. As in the case of high-income countries, the magnitude of the impact of exports is higher in the 1990s than that in the 1980s. In the case of low-income countries, exports do not seem to make a significant contribution to GDP growth. Indeed, the estimated coefficient of exports for the 1970s is negative, although it is not statistically significant. In the 1980s and 1990s exports seems to have positive contribution to GDP growth in low-income countries but the estimated coefficients are still not significant at the conventional levels. Broadly, the interactive terms between human capital, infrastructure and exports are positive and significant for high- and middle income countries, while it is not statistically significant for low-income countries. This again supports the notion that human capital and infrastructure have a significant impact in determining the effect of exports on GDP growth. We carried out further regressions using a panel data set, and the results are fairly similar with the results obtained in the cross section regressions. That is, the significant impact of exports is limited to high- and middle-income countries, while its contribution to GDP growth in low-income countries is insignificant.

9.2.4 Summary of results in Chapter 7

The causality tests in Chapter 7 provide further evidence that countries with low levels of development do not seem to benefit from openness. Using a multivariate model we have carried out causality tests between GDP growth, the ratio of exports to GDP, the ratio of imports to GDP and the ratio of FDI to GDP. In this analysis we used the error correction mechanism (ECM) model and Granger causality test to examine the direction of causality between the above variables. We considered a panel of 86 developed and developing countries for the period 1970-1999.

For the full sample of mixed countries, we obtained the results that there is a bi-directional causality between GDP and the ratio of export to GDP. The ratio of FDI in GDP also has a significant causality effect on GDP growth in the case of the full sample of countries. The ratio of imports to GDP, on the other hand, does not have a causality effect on GDP. With respect to high- and middle-income countries the results show that there is a bi-directional causality effect between GDP and the ratio of exports to GDP. However, for the sample of low-income countries, exports do not have a significant causality effect on GDP, but the direction of causality from GDP growth to ratio of export to GDP is statistically significant. In general, the causality test indicates that exports have a significant role in the growth of high- and middle-income countries, while in the case of low-income countries, they do not seem to have a significant impact on the growth of the economy.

The results also show that, for high- and middle-income countries, GDP and FDI have positive causality effects on exports, while imports do not have significant effect on exports. For high-income countries, GDP and exports appeared to have positive causality effect on imports, while in the middle-income countries only GDP has a causality effect on imports. In low-income countries both exports and imports seem to have negative causality effects on

GDP, though it is only exports which is statistically significant. FDI also does not have a significant causality effect on GDP in low-income countries. We also have seen that, in low-income countries, there is no significant causality relationship between exports and FDI and imports and FDI.

9.2.5 Summary of results in Chapter 8

In Chapter 8, we have developed a simultaneous equation model that considers six endogenous variables [GDP growth (gGDP), the ratio of investment to GDP (GDI), growth of exports (gEXP), the ratio of foreign direct investment to GDP (FDI), human capital (HK) and infrastructure (INFRA)]. The first equation states that GDP growth is determined by the growth of labour, the ratio of investment in GDP, the growth of exports, the ratio of foreign direct investment in GDP, human capital and infrastructure. The second equation aims at capturing the factors that affect domestic investment, and it states that GDI a function of one period lagged per capita income, the ratio of exports in GDP and the ratio of imports in GDP. The third equation posits the determinants of exports growth and is assumed to be a function of GDP growth, terms of trade, trade partner's GDP growth, growth of trade with OECD countries, export duties and trade partner's tariff rate. The fourth equation incorporates factors that determine FDI, which is assumed to be a function of human capital, infrastructure, rate of inflation and import duties. The fifth equation states that human capital is a function of GDP per capita, growth rate of population, the ratio of public expenditure on education to GDP and the ratio of female literacy rate. Finally, in equation six, infrastructure is assumed to be a function of GDP growth and per capita income.

The regression analysis is carried out by using an instrumental variable estimator for 86 developed and developing countries over the period 1970-1999. As in the case of other empirical chapters the results in Chapter 8 show that, for full sample of countries, there is a great deal of evidence in support of the positive impact of openness on economic growth. The results show that trade policy variables [duties on exports (XDUTY) and duties on imports (TARIFF)] have negative impact on GDP growth through their effects on growth exports and FDI, respectively. Trading partners' tariff rates (as proxied by the weighted average of OECD countries import duties) also have adverse effect on growth of exports and hence on GDP growth. Human capital (HK) and infrastructure (INFRA), on the other hand, make a significant positive contribution to GDP growth both directly and indirectly through their effect on FDI. Inflation, which enters in the regression as a proxy for macroeconomic instability has negative impact on GDP growth through its effect on FDI. The results for the full sample of countries reveal once again that openness to trade has a significant impact on GDP growth. However, the effect varies from one group of countries to another. The significant positive contribution of the growth of exports is limited to high- and middle-income countries. FDI also make a significant contribution only in the high- and middle-income countries. It might not necessarily mean that FDI does not have positive impact on GDP growth, but as a result of low level of human capital and poor quality infrastructure in low-income countries, the flow of foreign investment is relatively low. Therefore, the impact of FDI on GDP growth in low-income countries is not as significant as it is in high- and middle-income countries. In all groups of countries XDUTY and TARIFF seem to have negative impact on the growth of exports and FDI, respectively. However, their impact is statistically significant only in the case of high- and middle-income countries. More importantly, we have seen that, in all groups of countries, human capital and infrastructure make a significant contribution to GDP growth both directly and indirectly through their effect on FDI. Tariff levied by trading partners also seems to have a significant adverse effect on growth of exports of all groups of countries. On the other hand, an increase in trade with OECD countries has a positive effect on the growth of exports in all groups of countries, with its higher impact in the high-income countries.

Using panel data rather than simply averaging the time series component of the data as in the case of cross-section analysis, reveal that the results obtained in cross-section studies are dubious. One other problem that has been dealt with in this study is that all the previous studies have considered single equation models despite the fact that the relationship between trade and growth is clearly simultaneous in nature. This indicates that earlier studies suffer from single equation bias.

Rodriguez and Rodrik (2000) criticised the inappropriateness of various policy variables used in different empirical studies. They also have noted that selection of samples yield systematically bias results in favour of showing a statistically significant relationship between free trade and growth. We used a range of trade policy variables and different techniques to find that the impact of free trade on growth is heavily dependent on a country's level of human capital and quality of infrastructure.

9.3 Policy Implications

This thesis has examined whether the effect of openness on growth varies between countries of different stages of development. The most consistent and robust finding is that the effect on growth depends on the absorptive capacity of the country. Openness and trade have little or no effect on economic growth in low-income countries (with low level of development). However, the most consistent and robust finding is that openness and export growth have a significant growth-enhancing impact in the high- and middle-income countries.

From the policy point of view, the most important revelation is for the poorer developing (low-income) countries. The results show that the significant impact of openness or trade on growth is confined to high- and middle-income countries. This we argue is mainly due to the lack of adequate human capital and quality infrastructure, which are the key elements in the growth process of developing countries. Theoretically, less-developed countries are the ones that will be able to benefit from openness since movement towards free trade will introduce them to the world's stock of knowledge. However, knowledge spillover from the advanced economies to less-developed nations is by no means automatic and spontaneous. The role of human capital and infrastructure need to be emphasised in inducing the flow of technologies from one country to another, since they determine the absorptive capacity of a country. The lack of statistically significant results concerning openness in low-income countries is explained by their insufficient stock of human capital that would have enabled them to absorb new technologies and an inferior quality of infrastructure that deters foreign investment (which is one of the vehicles for knowledge spillovers).

In essence, the results in this thesis imply that while international trade is a potent driving force in the growth process of high- and middle-income countries, it has been exerting a meagre impact upon the growth of low-income countries. Furthermore, the results demonstrate, not surprisingly, that in all groups of countries, human capital and infrastructure make a significant contribution to economic growth. This provides strong support for a policy regime which demonstrates a judicious combination of trade policy reform and investment on education and infrastructure.

We find that aid plays a significant role in the growth process of low-income countries. The results also reveal that a reduction in tariff rates or other duties levied on trade should be accompanied by a higher volume of foreign aid. This seems to suggest that low-income countries need more aid in order to increase their absorptive capacity and to benefit from openness. The main policy implication for low-income countries that emerges from this study is that investment on education and improving the quality of infrastructure is a necessary condition to benefit from openness. For developing countries, the effective way of achieving a higher rate of growth via international trade is to invest more on education and infrastructure that will enable them to absorb new technologies from the advanced economies.

The results also show that the absorptive capacity of a country is crucial for obtaining significant benefits from FDI. Without adequate human capital and infrastructure knowledge transfer from FDI may not simply be feasible. For developing countries to take full advantage of a higher degree of openness and greater flows of FDI, trade liberalisation and FDI-related policies need to be accompanied by policy reforms that address the issue of education and infrastructure. It does seem to us that the beneficial effect of trade liberalisation on growth of low-income countries is a statement based on faith rather than evidence. To supplement the regression results for each group of countries, we carried out further regressions for different periods to examine whether the impact of openness varies at different periods as the stock of human capital increases and quality of infrastructure improves from one period to another.

We may suggest that giving more access to short- or long-term credit as required to invest on education, infrastructure and other related areas, either from the IMF, World Bank, or other financial sources will help low-income countries to build up their absorptive capacity. International commercial banks do not regard many of low-income countries as creditworthy, while aid donors have not been compliant or effective in providing sufficient development assistance. In recent years IMF, World Bank and other international institutions became active in financing developing countries for a range of projects including infrastructure, health and education, but this assistance is still unable to generate the appropriate conditions that will enable low-income countries to adopt new technologies. The empirical evidence, from the experience of the 1970-1999 period, strongly suggest that economic growth in low-income countries would be significantly increased by provision of increased international aid. Increased comprehensive development assistance could be used to improve the poor quality of infrastructure and the expansion of schools. Thus, it can be suggested here that international donors have to increase their development assistance directed at the improvement of infrastructure and human capital. Developing countries on their part have to focus on improving the education system and poor infrastructure.

9.4 Critical Assessment of the Study

We have provided reasonable interpretations of our results. We should, however, note that the evidences need to be accepted with caution. Our results have several limitations that might alter the results obtained in this study. The apparent problem is the arbitrary nature of classification of countries on the basis of their per capita income. Alternative methods of classification of countries that reflect the actual level of development may rank countries differently, and hence may alter the results. Furthermore, in this study countries are classified on the basis of their per capita income in 1995. Since our study covers for the period 1970-1999, it does not seem realistic to assume that all of these countries remain in the same income group through out this period.

In Chapters 4 and 5, our estimates of total factor productivity are Solow residuals obtained from the regression of GDP growth on growth of labour and capital. These estimates can only approximate the value of TFP. As noted earlier, the strong assumption about the homogeneity of technology across countries does not seem to be appropriate, since technological levels of countries are internationally different.

As noted earlier, the disparities in the proportion of exports to GDP could be due to other factors, such as country size and proximity of the country to major trading area. For example, the ratio of exports to GDP in large countries (such as, United States) might even be lower than for those of some of the low-income countries. Thus, taking such factors into consideration in the analysis of the impact of exports on growth might alter the findings of this study. It might thus be worthwhile to consider such factors in the analysis and to examine their impact on the growth or share of exports in GDP and hence on the growth of the economy.

In spite of the above limitations, we believe that the thesis has made significant contribution in the analyses of the relationship between trade, trade policy and economic growth. The empirical findings in this study are of vital importance for less-developed countries, as they provide evidence that these countries need to focus more on capacity building (by investing more on education and improving infrastructure) than to be obsessed by degrees of openness.

9.5 Direction for Future Research

Perhaps the most important finding in this study is that openness operates differently in countries that differ in their level of development. The stock of human capital and quality of infrastructure play a significant role in determining the absorptive capacity of a country. In this study we used secondary school enrolment as a proxy for human capital and main telephone lines as a proxy for infrastructure. Considering other proxies for human capital as well as infrastructure might be useful suggestions for further studies. For example, the presence of telephone service is principally assumed as a means of information transformation across the countries. Other factors, such as roads, railways and mass communication (radio, television, newspapers, etc), might also be good proxies for infrastructure.

Although the findings in this study emphasise that the impact of openness depends on the level of development of the countries, the method (per capita income) we used to classify the sample of countries is arbitrary. Finding education and/or infrastructure threshold might be a better method to indicate the minimum level of development that is required to benefit from openness. There has not been any literature that considers such threshold in the analysis of the impact of openness on economic growth. It might, therefore, be worthwhile to consider such factors as they might give some evidence as to the extent to which the impact of openness on growth is conditioned by human capital and infrastructure. Furthermore, there could be significant difference between countries in the same group. For example, lower middle-income countries might share some or more economic characteristics with low-income countries than upper middle-income countries. Therefore, further studies may need to be done by taking such factors into consideration when considering the level of development in the analysis of the impact of openness on growth.

We also have noted that our estimates of TFP growth can only give approximate values, because of the assumption we imposed on the homogeneity of technology in the growth equation. It is clear, however, that the level of technology is different between countries. It may, thus, be suggestive to consider a model that allows heterogeneity of technology across the countries.

We have noted earlier that the differences in the ratio of exports in GDP does not necessarily reflect the degree of openness, since it could be affected by other factors, such as country size and proximity of the country to major trading area. Moreover, the composition and value of exports are also different between countries. Developed countries mainly export manufacturing goods, while low-income countries export primary goods. Such disparities might also make a difference to their impact on economic growth. It might thus be, worthwhile to consider such factors in the analysis and examine their impact on the growth or share of exports in GDP and hence on growth of the economy.

There has not been much econometric analysis at plant-level in relation to trade and economic growth. As Roberts and Tybout (1996) noted, such analysis may also reveal how trade and trade policy affect productivity, employment and technological performance of firms. In future studies researchers may have to consider such factors in the analysis of the relationship between trade policies and economic growth.

Appendix 1

Absorptive Capacity

In this study we emphasise that the impact of openness on economic growth depends on the absorptive capacity of the country. Absorptive capacity can be considered to have two major elements: learning ability and the incentives or barriers to implementing new technologies. The term 'absorptive capacity' is similar to Abramivitz's (1986, 1999) concept of 'social capability'. Also, in somehow related, literature on national systems of innovation there is a focus on the capability of the economy to adopt and develop new technology (see for e.g. Mowery and Oxley, 1995), who use the term ' absorptive capability'). Finally, similar concepts are found in theoretical models, for example, Goodfriend and McDemermott (1998) use the concept of a country's 'familiarity' with a foreign economy as a parameter in an endogenous growth model with technological catch-up. Accessibility to foreign technology depends o various factors: business, educational, and social links; the level of trade in goods and services; and foreign direct investment. Countries with relatively high linkages would be thought of as having the prerequisites for technological catch-up. Openness by itself cannot generate economic growth. The ability to learn and understand new technology depends on a wide range of factors. At a basic level, education (human capital) is clearly important along with quality of infrastructure.

A number of theoretical and empirical studies have shown that human capital plays important role in the process of growth (e.g., Lucas, 1986, 1988; Barro, 1995; Grossman and Helpman, 1991). Developing countries, in particular, need sufficient educated people that can understand and implement sophisticated foreign technology. Therefore, it is reasonable to assume that for openness to work in developing countries they need to have adequate stock of human capital. We include human capital variable to test its direct impact on economic growth as well as its indirect effect through openness variables. In the regressions that follow we test the impact of openness variables without human capital and then examine the changes when human capital is included in the regression. Furthermore, we test its impact by including the interactive term in the regression.

The telecommunication variable is indicator of the level of infrastructure present in a country that is principally concerned with the transfer of information. We employ the number of telephone lines per 1000 inhabitants. This proxy have been used by other studies (for example, Canning, 1999; Canning and Pedroni, 2000). Infrastructure is assumed to facilitate communications across countries. Infrastructure is assumed to determine the

Appendix 2

A Model of Technological Catch up

Consider a basic TFP growth model of an open economy in which total output (Y) is assumed to be a function of physical capital (K), labour (L) and the level of technology, or total factor productivity (A):

$$Y_t = A_t f(K_t, L_t) \qquad \text{(A1)}$$

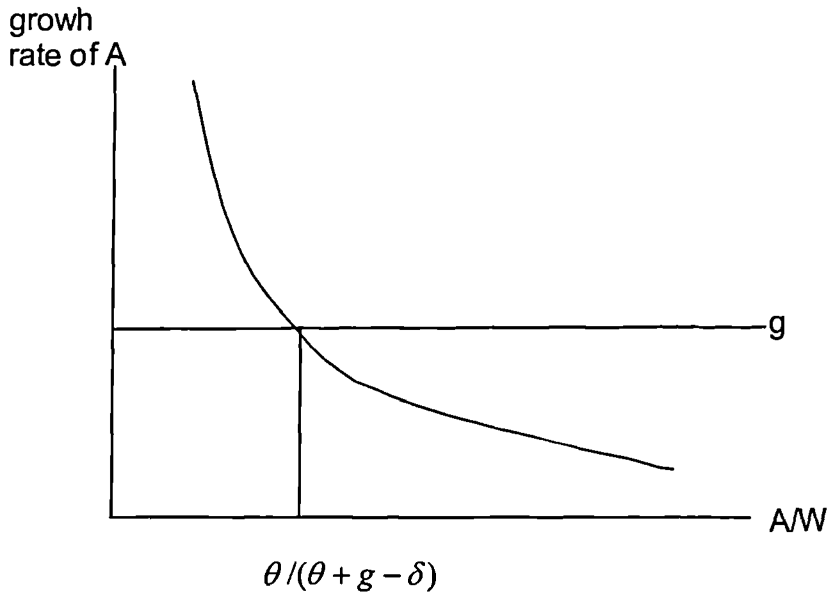
The rate of growth of GDP is assumed to be determined by the rate of changes in these three factors of production. There are two sources of TFP growth; namely, innovation and imitation. Innovation is related to the ability of the nation to develop new idea, while imitation is associated with the ability of the country to adopt new technologies developed elsewhere. The domestic level of human capital determines the rate at which the nation innovates new products, while imitation depends on a catch up term, which means that countries with lower initial stock of knowledge tend to grow faster.

A standard equation to describe the growth of total factor productivity is:

$$\dot{A}/A = \delta + \theta(W - A)/A \quad , \qquad \text{(A2)}$$

where W denotes the level of world stock of knowledge, which is assumed to grow at a constant rate of g; θ is the speed at which a country closes the knowledge gap and it is assumed that θ depends on the domestic trade policy; δ represents the domestic rate of innovation that is assumed to be determined by the level of accumulated human capital and not to exceed the growth rate of the world stock of knowledge (g). For an advanced country it is clear that $\delta = g$, and $W = A$. Thus unless W equals A, the right-hand side of equation 4.2 must be changing, leading A to change. This phenomenon is illustrated in Figure 4.1.

Figure A2.1 Technological gap



In the above figure countries with technology ratio (A/W) below the long run equilibrium level $\theta/(\theta+g-\delta)$ will experience higher rate of growth compared to the rate of growth of world stock of knowledge. In contrast, countries with higher technological ratio above $\theta/(\theta+g-\delta)$ will experience lower rate of growth than *g*.

In the context of trade policy and economic growth, countries pursuing outward-oriented policy are assumed to have greater opportunity to absorb new technologies from the rest of the world, such that these countries achieve higher value of θ. Following this the stock of knowledge of the country is assumed to converge to $[\theta/(\theta+g-\delta)]W$ leading to an equilibrium gap between the country's and the world's level of TFP. The model implies that countries with outward oriented policy tend to have higher steady-state stock of knowledge and hence (assuming other things being constant) higher rate of growth of GDP than those who pursue inward-oriented policy. At the steady-state equilibrium, all trading countries will have TFP growth rate of g, as long as $\theta > \delta$. The fundamental implication of the model lies on TFP growth, while the initial level of stock of knowledge is positively related to TFP growth. The model emphasises that countries with free trade policy tend to experience higher growth rate than those who implement distortionary measures. Moreover, the model implies that the level of human capital have a positive impact on TFP growth, while initial level of technology has negative effect. We carry out the analysis by regressing growth of TFP on six alternative openness indicators.

Appendix 3

Algeria
Angola
Argentina
Australia
Bangladesh
Belgium
Bolivia
Brazil
Cameroon
Canada
Chile
China
Colombia
Costa Rica
Cote d'Ivoire
Cyprus
Denmark
Dominican Republic
Ecuador
Egypt
El Salvador
Ethiopia
Finland
France
Germany
Ghana
Greece
Guatemala
Guyana
Haiti
Honduras
Iceland
India
Indonesia
Iran
Ireland
Israel
Italy
Jamaica
Japan
Jordan
Kenya
Korea
Kuwait
Luxembourg
Madagascar
Malaysia
Malawi
Mali
Malta
Mauritius
Mexico
Morocco
Mozambique
Myanmar
Netherlands
New Zealand
Nicaragua
Nigeria
Norway
Pakistan
Panama
Paraguay
Peru
Philippines
Portugal
Rwanda
Senegal
Sierra Leone
Singapore
South Africa
Spain
Sri Lanka
Sweden
Sweden
Switzerland
Taiwan
Tanzania
Thailand
Trinidad
Tunisia
Turkey
United Kingdom
United States
Uganda
Uruguay
Venezuela
Zaire
Zambia
Zimbabwe

Appendix 4

Strongly Outward Oriented

Korea, Rep. of
Singapore

Moderately Outward Oriented:

Chile
Israel
Malaysia
Tunisia
Turkey
Uruguay

Moderately Inward Oriented:
Colombia
El Salvador
Honduras
Côte d'Ivoire
Kenya
Mexico
Nicaragua
Pakistan
Philippines
Senegal

Strongly Inward Oriented

Argentina
Bangladesh
Dominican Republic
India
Nigeria
Peru
Zambia

Appendix 5

High- income	Middle-income	Low-income
Australia	Algeria	Angola
Belgium	Argentina	Bangladesh
Canada	Bolivia	Cameroon
Cyprus	Brazil	China
Denmark	Chile	Cote d'Ivoire
Finland	Colombia	Ethiopia
France	Costa Rica	Ghana
Greece	Dominican Republic	Haiti
Iceland	Ecuador	Honduras
Ireland	Egypt	India
Israel	El Salvador	Indonesia
Italy	Guatemala	Kenya
Japan	Guyana	Madagascar
Kuwait	Iran	Malawi
Luxembourg	Jamaica	Mali
Malta	Jordan	Mozambique
Netherlands	Korea, Rep.	*Myanmar*
New Zealand	Malaysia	Nicaragua
Norway	Mauritius	Nigeria
Portugal	Mexico	Pakistan
Singapore	Morocco	Rwanda
Spain	Panama	Senegal
Sweden	Paraguay	Sierra Leone
Switzerland	Peru	Sudan
United Kingdom	Philippines	Tanzania
United States	Romania	Uganda
	South Africa	Zaire
	Sri Lanka	Zambia
	Thailand	Zimbabwe
	Trinidad and Tobago	
	Tunisia	
	Turkey	
	Uruguay	
	Venezuela	

Appendix 6

Middle-income	Low-income
Algeria	Angola
Argentina	Bangladesh
Bolivia	Burkina Faso
Botswana	Burundi
Brazil	Cameroon
Chile	Chad
Colombia	China
Costa Rica	Cote d'Ivoire
Dominican Republic	Ethiopia
Ecuador	Ghana
Egypt	Haiti
El Salvador	Honduras
Gabon	India
Guatemala	Indonesia
Guyana	Madagascar
Iran	Malawi
Jamaica	Mali
Jordan	Mozambique
Korea, Rep.	Myanmar
Malaysia	Nepal
Mauritius	Nicaragua
Mexico	Nigeria
Morocco	Pakistan
Panama	Rwanda
Paraguay	Senegal
Peru	Sierra Leone
Philippines	Tanzania
South Africa	Uganda
Sri Lanka	Zaire
Swaziland	Zambia
Trinidad and Tobago	Zimbabwe
Tunisia	
Turkey	
Uruguay	
Venezuela	

Appendix 7

Figure A7.1: The ratio of trade to GDP

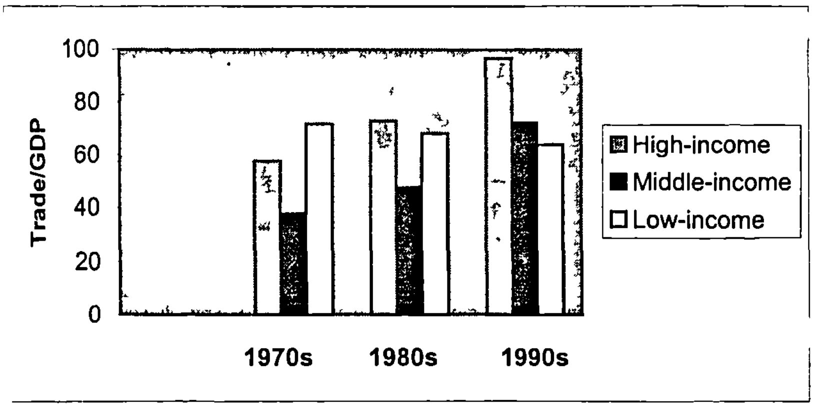


Figure A7.2: Black market premium

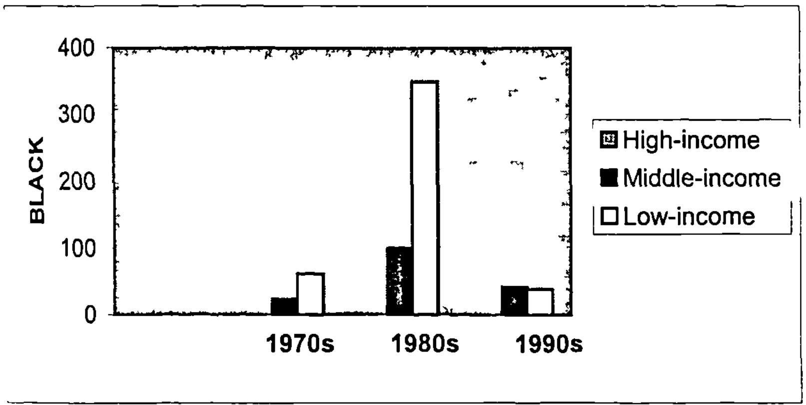


Figure A7.3: Tariff rate

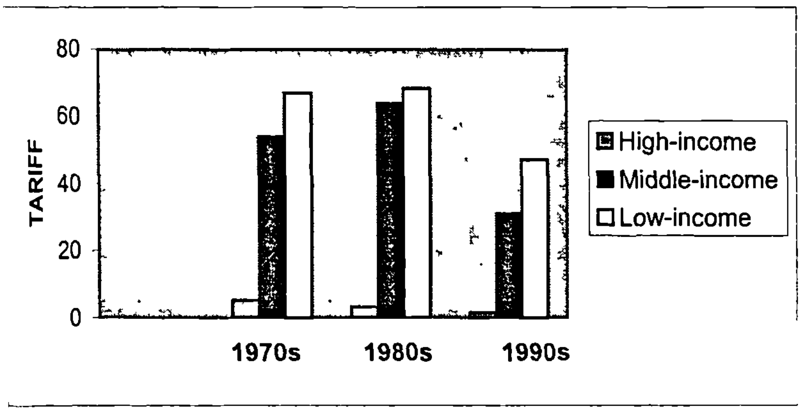
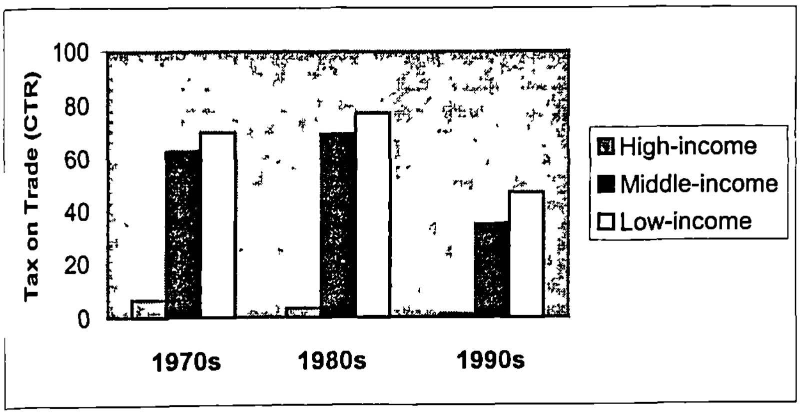


Figure A7.4: Collected Tax on International Trade



Appendix 8

High- income	Middle-income	Low-income
Australia	Algeria	Angola
Belgium	Argentina	Bangladesh
Canada	Bolivia	Cameroon
Denmark	Brazil	China
Finland	Chile	Cote d'Ivoire
France	Colombia	Ethiopia
Greece	Costa Rica	Ghana
Iceland	Dominican Republic	Haiti
Ireland	Ecuador	Honduras
Israel	Egypt	India
Italy	El Salvador	Indonesia
Japan	Guatemala	Kenya
Netherlands	Guyana	Madagascar
New Zealand	Iran	Malawi
Norway	Jamaica	Mali
Portugal	Jordan	Mauritania
Singapore	Korea, Rep.	Mozambique
Spain	Malaysia	Myanmar
Sweden	Mauritius	Nicaragua
Switzerland	Mexico	Nigeria
United Kingdom	Morocco	Pakistan
United States	Panama	Rwanda
	Paraguay	Senegal
	Peru	Sierra Leone
	Philippines	Sudan
	Romania	Tanzania
	South Africa	Uganda
	Sri Lanka	Zaire
	Thailand	Zambia
	Trinidad and Tobago	Zimbabwe
	Tunisia	
	Turkey	
	Uruguay	
	Venezuela	

Appendix 9

Unit Roots Test

We begin the panel regression by carrying out unit root tests on each of the variables that are considered in the empirical analysis. One method is to examine the time series of each country independently and test if it a unit root. However, recent studies (e.g., Levin and Lin, 1993; Quah, 1994; Im, Pesaran and Shin, 1997; Hadri, 1999; Madalla and Wu, 1999) have found that the power of the test increases with the increase in the number of cross-sections. To examine the order of integration of each variable, we adopt the alternative approach that is proposed by Im, Pesaran and Shin, 1997 (thereafter denoted as IPS). This method is used to carry out a panel unit root test for the joint null hypothesis that every time series in the panel is non-stationary. IPS proposed two methods of unit root tests: t-bar and LM-bar statistics. t-bar statistic is computed by running a standard augmented Dicke-Fuller (ADF) unit root test for each country and taking the average of t-values of the test statistic found. The LM-bar test, on the other hand, is based on the average of the Lagrange multiplier statistics computed for each country in the panel for testing unit root in ADF regressions of order p_i. Assuming that data from each country are statistically independent, the average t-bar and LM-bar statistics can be considered as the averages of independent random draws from a distribution with known mean and variance. The IPS approach provides powerful test of the unit root hypothesis than the commonly used time series test, since this method allows the coefficients and errors to be heterogeneous across countries in ADF equations. Note here that by running each ADF regression separately, we allow each country to attain its own short-run dynamic.

The ADF test is based on the following model:

$$\Delta y_{it} = \alpha_i + \beta_i y_{i,t-1} + \Sigma_{j=1}^{p_i} \rho_{ij} \Delta y_{i,t-j} + \varepsilon_{it} \quad , \qquad \text{(A7.1)}$$

where i = 1, 2, ..., N, and t = 1, 2, ... , T. Δ is the first order difference operator, y_{it} is the variable under consideration and j = 1, 2, ... , p_i is the lag length of Δy_{it}. ρ_i is the estimated vector of coefficients on the augmented lagged differences.

The standardised t-bar and LM-bar statistics are given as:

$$\Psi_{\bar{t}} = \frac{\sqrt{N}\left\{\bar{t}_{iT}(p_i,\rho_i) - \frac{1}{N}\Sigma_{i=1}^{N} E[t_{iT}(p_i,0)|\beta_i = 0]\right\}}{\sqrt{\frac{1}{N}\Sigma_{i=1}^{N} Var[t_{iT}(p_i,0)|\beta_i = 0]}} \quad \text{(A7.2)}$$

$$\Psi_{\overline{LM}} = \frac{\sqrt{N}\left\{\overline{LM}_{iT}(p_i,\rho_i) - \frac{1}{N}\Sigma_{i=1}^{N} E[LM_{iT}(p_i,0)|\beta_i = 0]\right\}}{\sqrt{\frac{1}{N}\Sigma_{i=1}^{N} Var[LM_{it}(p_i,0)|\beta_i = 0]}}, \quad \text{(A7.3)}$$

where i = 1, 2, …, N and T denote the number of countries and time periods, respectively. $t_{iT}(p_i,\rho_i)$ is the individual ADF statistic for testing the unit root (i.e., $\beta_i = 0$). $LM_{it}(p_i,\rho_i)$ is the individual LM statistic for testing unit root. IPS tabulate values of $E(t_{iT})$, $V(t_{iT})$, $E(LM_{iT})$ and $V(LM_{iT})$. Under the null hypothesis of a unit root, both t-bar and LM-bar statistics have standard normal distribution.

Following the IPS suggestion, we regress each variable on a set of time dummies and take the residuals. This method is used to remove any common time effects and reduce the risk of correlation across countries. Each of ADF regression will include both a constant and time trend. The optimal selection of lag length should be determined based on the properties of the residuals. We start by setting a higher lag length (p_i = 5), and then depending on the residuals white noise process we select the appropriate lag length.

Appendix 10

	High-income				Middle-income					Low-income				
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*
lnGDP70	-0.02 (-2.68)	-0.03 (-2.66)	-0.02 (-2.62)	-0 02 (-2.63)	-0.002 (-2.07)	-0.002 (-2.06)	-0 003 (-2.09)	-0.003 (-2.10)	-0 004 (-2.12)	-0 0003 (-1.83)	-0.0004 (-1.85)	-0.0005 (-1.85)	-0.0004 (-1.86)	-0.0003 (-1.84)
ln HK70	0.02 (3.11)	0.02 (3.13)	0.01 (3.10)	0.01 (3.17)	0.004 (2.17)	0.004 (2.15)	0 004 (2.15)	0.003 (2.12)	0.003 (2.13)	0.001 (1.85)	0.001 (1.86)	0.002 (1.88)	0.001 (1.88)	0.001 (1.87)
ln TRADE	0.19 (3.76)				0.09 (2.65)					0.03 (1.60)				
ln BLACK						-0.04 (-2.90)					-0.02 (-2.77)			
ln TARIFF		-0.01 (-2.42)					-0.001 (-2.22)					0.002 (2.12)		
Ln CTR			-0.05 (-2.57)					-0.004 (-2.37)					0.0005 (1.96)	
ln DISTORT				-0.01 (-2.54)					-0.003 (2.26)					0.001 (1.82)
ln TRADE**ln HK*ln TARIFF	0.12 (2.66)				0.07 (2.33)					0.05 (1.87)				
ln BLACK**lHK*ln INFRA						-0.05 (-2.95)					-0.005 (-2.41)			
ln TARIFF*lnHK*ln INFRA		-0.004 (-2.23)					-0.001 (-2.10)					-0.007 (-2.21)		
ln CTR*ln HK*lnINFRA			-0.008 (-2.45)					-0.002 (-2.30)					-0.006 (-1.80)	
ln DISTORT*lnHK*ln INFRA				-0.002 (-2.25)					-0.003 (-2.15)					-0.003 (-1.95)
ln HK	0.06 (2.64)	0.05 (2.60)	0.05 (2.59)	0.06 (2.65)	0.07 (2.72)	0.07 (2.69)	0.06 (2.64)	0.06 (2.66)	0.07 (2.72)	0.02 (2.43)	0.02 (2.45)	0.01 (3.34)	0.01 (2.34)	0.01 (2.39)
R^2	0.73	0.74	0.74	0.74	0.81	0.82	0.81	0.82	0.82	0.64	0.64	0.65	0.64	0.63
N	660	660	660	660	1020	1020	960	960	960	900	900	840	840	840
AR	0.096	0.088	0.0109	0.0098	0.0121	0.0134	0.0110	0.0141	0.0105	0.0144	0.0137	0.0141	0.0150	0.0142
HS	5.07	3.91	4.14	4.72	3.47	3.60	3.69	3.41	3.28	5.13	4.93	4.17	5.25	5.19

Note: Figures in parentheses are heteroschedasticity corrected t-ratio (White, 1981). Ln GDP70 and ln HK70 are initial levels of income per capita and human capital. Trade is ratio of exports and imports in GDP. SW denotes binary openness measure as defined by Sachs and Warner (1995).BLACK is black market premimium. TARIFF is import duty. CTR is collected tax on trade. DISTORT is measure of trade distortion (i.e. $1+t_m$) $(1-t_x)$, where t_m and t_x are duties on imports and exports, respectively. AR denote the estimated autocorrelation coefficient. Values close to 0 indicate no autocorrelation problem. Due to space restriction we can not report significance levels in this table.

[redacted]

Testing for interaction between openness and infrastructure
Dependent Variable: TFP growth. Fixed effect estimator (1970-1999)

	High-income				Middle-income					Low-income				
lnGDP70	-0.02 (-2.65)	-0.03 (-2.64)	-0.02 (-2.60)	-0.02 (-2.61)	-0.002 (-2.03)	-0.002 (-2.03)	-0.002 (-2.05)	-0.003 (-2.07)	-0.003 (-2.08)	-0.0003 (-1 81)	-0.0004 (-1.82)	-0.0005 (-1.84)	-0.0004 (-1.85)	-0.0003 (-1.82)
ln HK70	0.04 (3.09)	0.01 (3.11)	0.01 (3.10)	0.01 (3.13)	0.004 (2.15)	0.004 (2.13)	0.004 (2.14)	0.003 (2.11)	0.003 (2.10)	0.001 (1.85)	0.001 (1.84)	0.002 (1.89)	0.001 (1.85)	0.001 (1.85)
ln TRADE	0.21 (3.82)				0.10 (2.69)					0.04 (1.63)				
ln BLACK						-0.04 (-2.93)					-0.02 (-2.79)			
ln TARIFF		-0.02 (-2.46)					-0.001 (-2.25)					0.002 (2.09)		
Ln CTR			-0.06 (-2.62)					-0.005 (-2.40)					0.0005 (1.98)	
ln DISTORT				-0.01 (-2.56)					-0.003 (2.29)					0.001 (1.80)
*ln TRADE**ln HK*ln TARIFF*	0.14 (2.70)				0.08 (2.37)					0.07 (1.92)				
*ln BLACK**lHK*ln INFRA*						-0.05 (-2.97)					-0.006 (-2.45)			
*ln TARIFF*lnHK*ln INFRA*		-0.006 (-2.31)					-0.001 (-2.14)					-0.009 (-2.27)		
*ln CTR*ln HK*lnINFRA*			-0.01 (-2.49)					-0.003 (-2.35)					-0.007 (-1.83)	
*ln DISTORT*lnHK*ln INFRA*				-0.002 (--2.27)					-0.004 (-2.19)					-0.003 (-1.98)
ln HK	0.05 (2.61)	0.04 (2.57)	0.04 (2.55)	0.05 (2.62)	0.07 (2.70)	0.07 (2.68)	0.05 (2.61)	0.06 (2.64)	0.07 (2.70)	0.01 (2.39)	0.02 (2.43)	0.009 (3.30)	0.009 (2.31)	0.01 (2.37)
ln INFRA	0.02 (2.49)	0.02 (2.47)	0.01 (2.43)	0.02 (2.47)	0.01 (2.39)	0.01 (2.33)	0.009 (2.28)	0.009 (2.27)	0.009 (2.28)	0.006 (2.13)	0.006 (2.11)	0.005 (2.08)	0.006 (2.12)	0.006 (2.13)
R^2	0.79	0.79	0.79	0.80	0.86	0.87	0.87	0.88	0.87	0.68	0.69	0.69	0.69	0.68
N	660	660	660	660	1020	1020	960	960	960	900	900	840	840	840
AR	0.0117	0.0102	0.0128	0.0119	0.0165	0.0179	0.0153	0.0190	0.0142	0.0176	0.0161	0.0165	0.0182	0.0170
HS	6.19	5.80	5.93	6.10	4.92	4.63	5.01	4.83	4.79	6.67	6.15	5.78	6.55	6.47

Note: Figures in parentheses are heteroschedasticity corrected t-ratio (White, 1981). Ln GDP70 and ln HK70 are initial levels of income per capita and human capital. Trade is ratio of exports and imports in GDP. SW denotes binary openness measure as defined by Sachs and Warner (1995).BLACK is black market premimium. TARIFF is import duty. CTR is collected tax on trade. DISTORT is measure of trade distortion (i.e. $1+t_m$) $(1-t_x)$, where t_m and t_x are duties on imports and exports, respectively. AR denote the estimated autocorrelation coefficient. Values close to 0 indicate no autocorrelation problem. Due to space restriction we can not report significance levels in this table.

Appendix 11

High- income	Middle-income	Low-income
Australia	Algeria	Angola
Austria	Argentina	Bangladesh
Belgium	Bolivia	Burkina Faso
Canada	Brazil	Cameroon
Cyprus	Chile	China
Denmark	Colombia	Cote d'Ivoire
Finland	Costa Rica	Ethiopia
France	Dominican Republic	Ghana
Greece	Ecuador	Haiti
Iceland	Egypt	Honduras
Ireland	El Salvador	India
Israel	Guatemala	Indonesia
Italy	Guyana	Kenya
Japan	Iran	Madagascar
Kuwait	Jamaica	Malawi
Malta	Jordan	Mali
Netherlands	Korea, Rep.	Mozambique
New Zealand	Malaysia	Myanmar
Norway	Mauritius	Nepal
Singapore	Mexico	Nicaragua
Spain	Morocco	Nigeria
Sweden	Panama	Pakistan
Switzerland	Paraguay	Rwanda
United Kingdom	Peru	Senegal
United States	Philippines	Sierra Leone
	Romania	Tanzania
	South Africa	Uganda
	Sri Lanka	Zaire
	Suriname	Zambia
	Swaziland	Zimbabwe
	Thailand	
	Trinidad and Tobago	
	Tunisia	
	Turkey	
	Uruguay	
	Venezuela	

Appendix 12

Root-mean square simulation error (RMSE)

The root-mean-square simulation error (RMSE) for the variable Y_t is defined as:

$$RMSE = \sqrt{\frac{1}{T}\sum_{t=1}^{T}(Y_t^s - Y_t^a)^2} \quad ,$$

where Y_t^s = simulated value of Y_t

Y_t^a = actual value

T = number of periods in the simulation

The *RMSE* is a measure of the deviation of the simulated variable from the actual time path.

Appendix 13
Theil's Inequality Coefficient

Theil's (1961) inequality coefficient is an important simulation statistic related to the RMSE and applied to the evaluation of historical simulation. Theil's inequality coefficient is defined as:

$$T = \frac{\sqrt{\frac{1}{T}\sum_{t=1}^{T}(Y_t^s - Y_t^a)^2}}{\sqrt{\frac{1}{T}\sum_{t=1}^{T}(Y_t^s)^2} + \sqrt{\frac{1}{T}\sum_{t=1}^{T}(Y_t^a)^2}}$$

Note here that the numerator is the *RMSE*, but the scaling of the denominator is such that the value T ranges between 0 and 1.

Theil's inequality coefficient is decomposed as follows:

$$\frac{1}{T}\Sigma(Y_t^s - Y_t^a)^2 = (\overline{Y}^s - \overline{Y}^a)^2 + (\sigma_s - \sigma_a)^2 + 2(1-\rho)\sigma_s\sigma_a \quad ,$$

where $\overline{Y}^s, \overline{Y}^a, \sigma_s$ and σ_a are the means, standard deviation of Y_t^s and Y_t^a, respectively, and ρ represents their correlation coefficient. That is, $\rho = (\frac{1}{\sigma_s}\sigma_a T)\Sigma(Y_t^s - \overline{Y}^s)(Y_t^a - \overline{Y}^a)$

The proportions of inequality is given as follows:

$$T^B = \frac{(\overline{Y}^s - \overline{Y}^a)^2}{(1/T)\Sigma(Y_t^s - Y_t^a)^2}$$

$$T^V = \frac{(\sigma_s - \sigma_a)^2}{(1/T)\Sigma(Y_t^s - Y_t^a)^2}$$

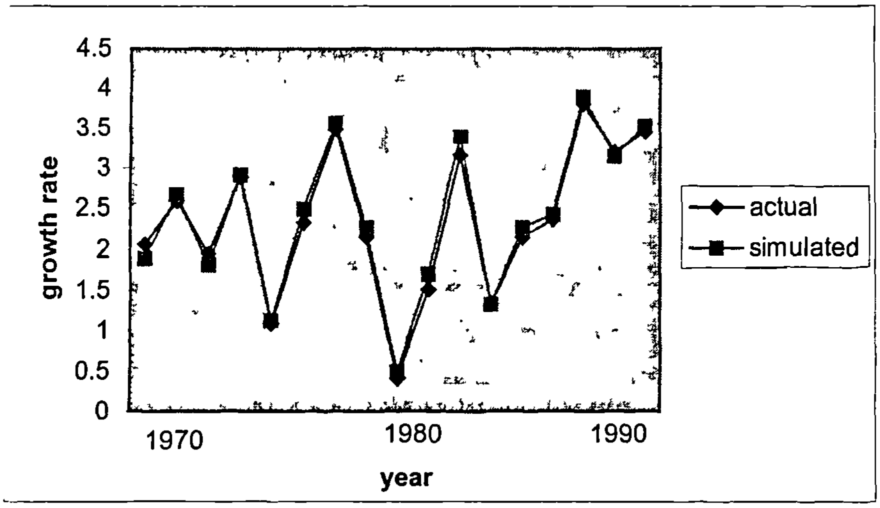
and

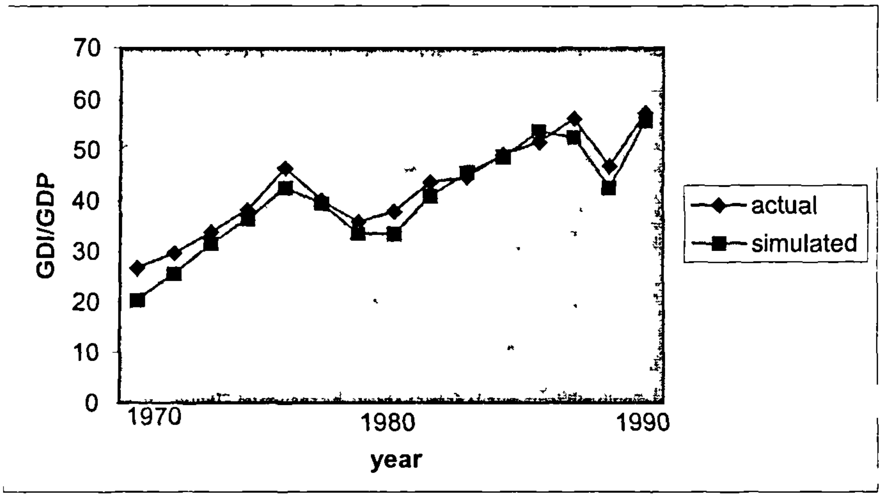
$$T^C = \frac{2(1-\rho)\sigma_s\sigma_a}{(1/T)\Sigma(Y_t^s - Y_t^a)^2}$$

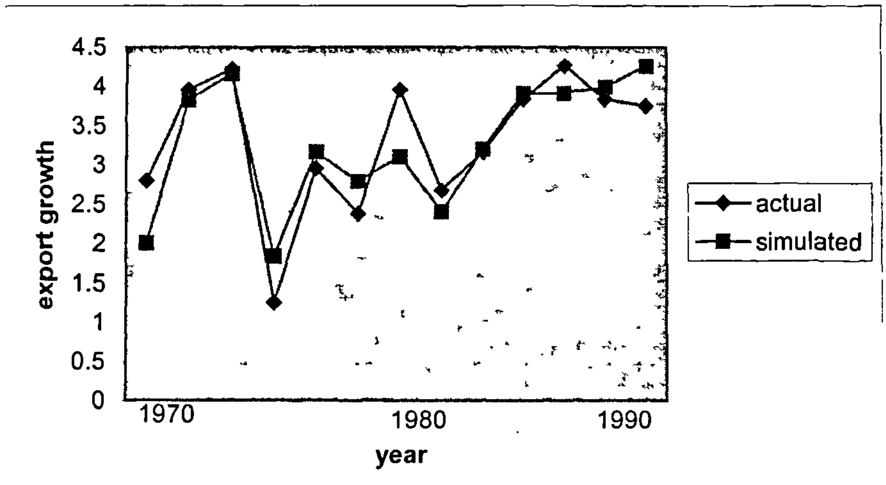
The proportions T^B, T^V and T^C are known as the bias, the variance, and the covariance proportions, respectively. T^B measures the extent to which the average values of the simulated and actual series deviated from each other. We do expect or hope T^B to be close to zero. T^V indicates the ability of the model to replicate the degree of variability in the variable of interest. Large values imply the actual series fluctuated considerably while the simulated series shows less fluctuation, suggesting the model is not good. T^C represents the remaining error after deviations from average values have been accounted for. Usually, expected to have values close to 1.

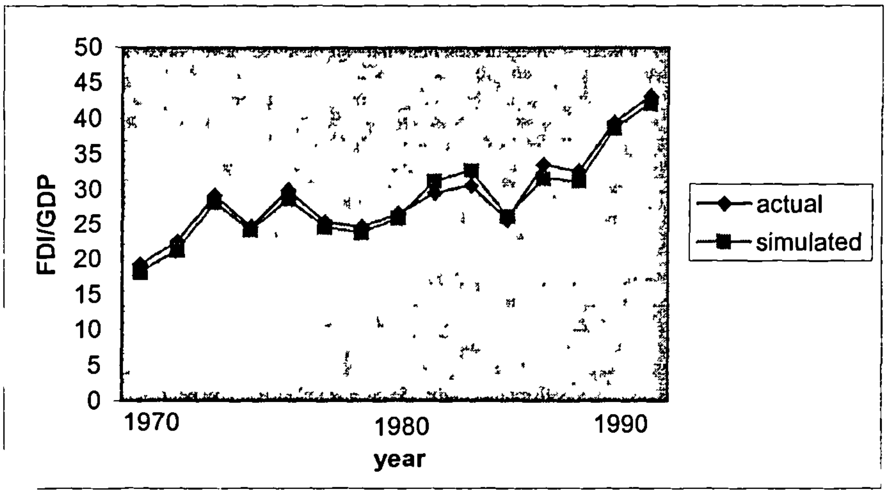
Appendix 14

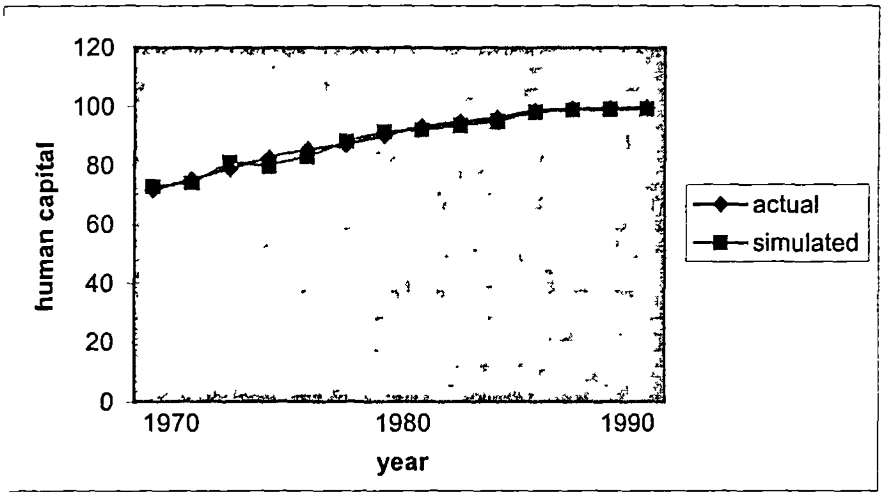
High-income Countries



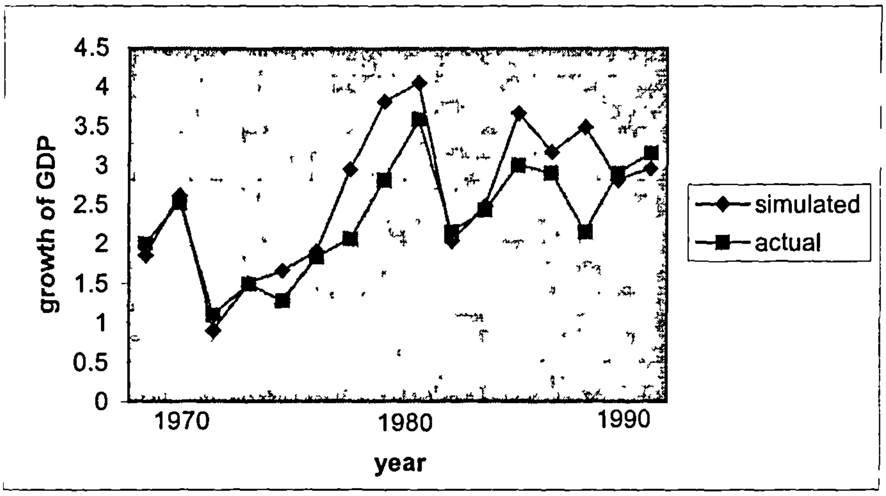


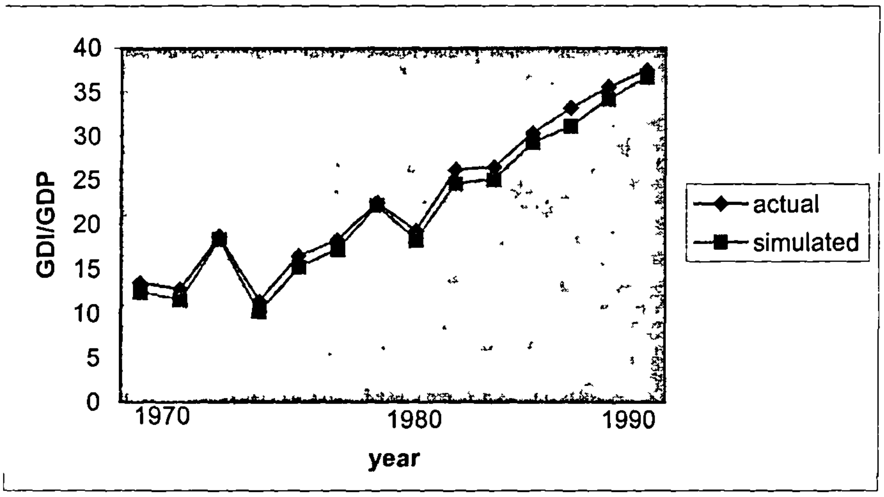


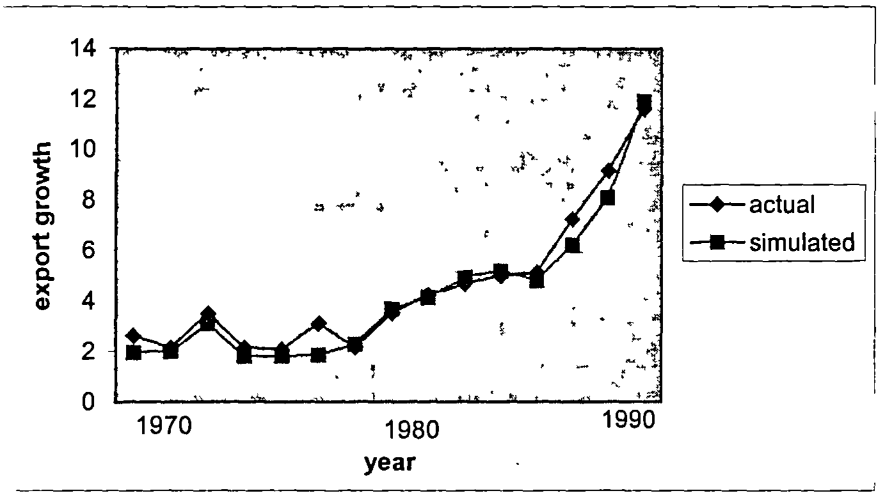

FDI/GDP
50
45
40
35
30
25
20
15
10
5
0
1970
1980
1990
year
actual
simulated

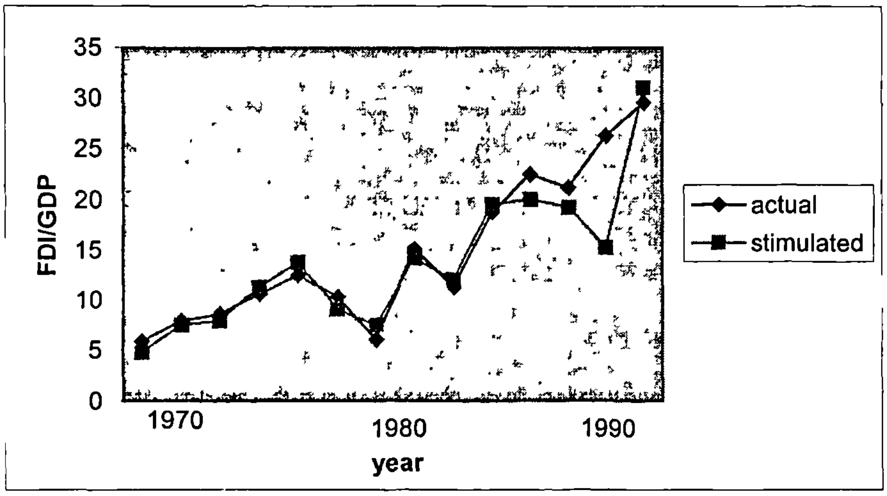

human capital
120
100
80
60
40
20
0
1970
1980
1990
year
actual
simulated

Middle-income Countries

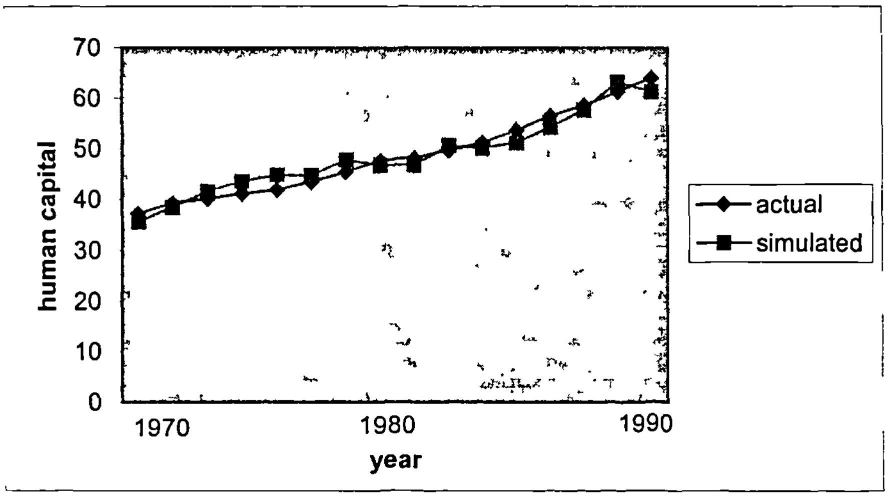






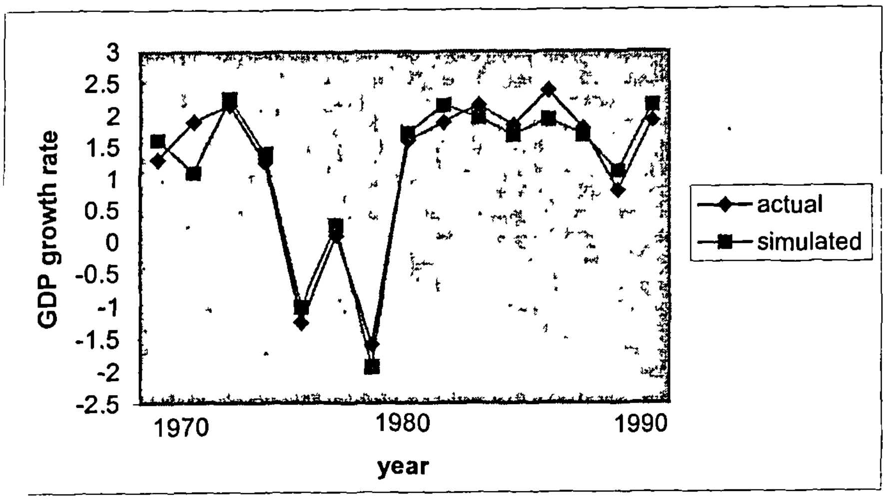


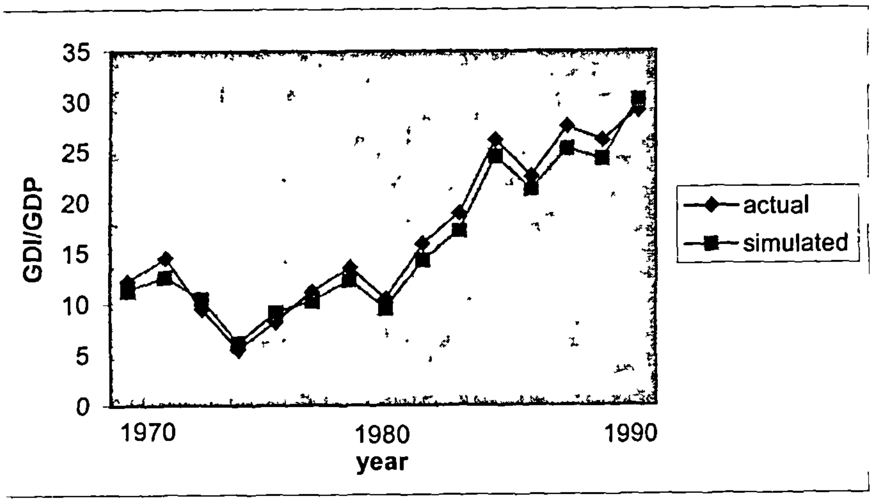
35
30
25
20
15
10
5
0
FDI/GDP
1970
1980
1990
year
actual
stimulated

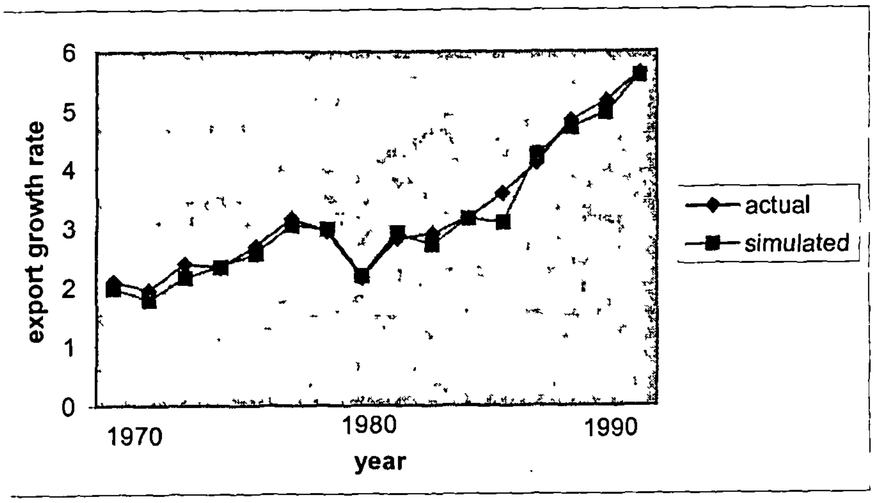


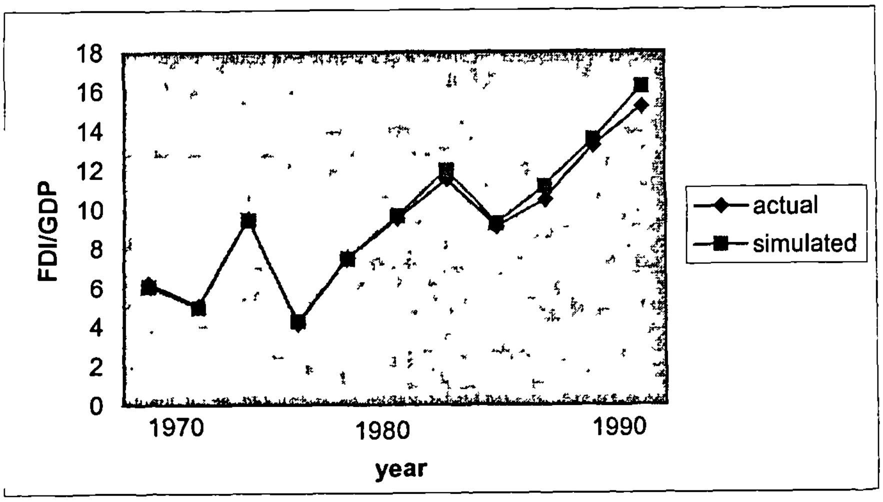
70
60
50
40
30
20
10
0
human capital
1970
1980
1990
year
actual
simulated

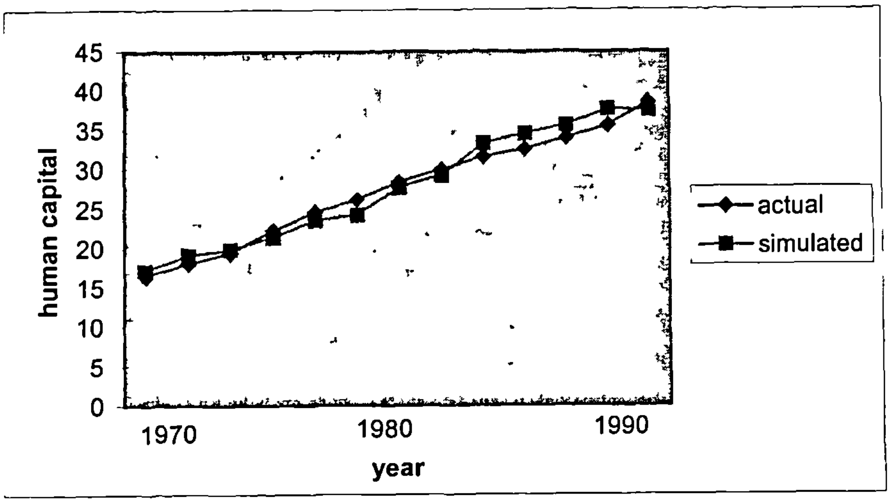
Low-income Countries








18
16
14
12
10
8
6
4
2
0
FDI/GDP
1970
1980
1990
year
actual
simulated


45
40
35
30
25
20
15
10
5
0
human capital
1970
1980
1990
year
actual
simulated

Appendix 15

Data

The following variables are used in the empirical analyses. Note that in the panel data analyses we extrapolated some of the observations for the missing data.

GDP growth: rate of growth of real GDP, which is computed as log differences. Data were obtained from the World Development Indicators (2000) and Easterly and Sewedeh (2001).

Growth physical capital: equals the annual growth rate of stock of physical capital. Data obtained from Nehru and Dhareshwar (1993)

Growth of labour force: equals the annual rate of growth of labour force. Data obtained from Nehru and Dhareshwar (1993); World Development Indicators (2000) and Easterly and Sewedeh (2001).

Human capital: This measures the ratio of total Secondary school enrolment, regardless of age, to the population of the age group that officially corresponds to the level of education. Data obtained from World Development Indicators (2000) and Easterly and Sewedeh (2001). We also use two alternative measure: Public expenditure on education, which is the percentage of GNP accounted for by public spending on public education plus subsidies to private education at secondary level ratio of education expenditure to GDP. Data obtained from World Development Indicators (2000).

Initial income per capita: This is the value of real per capita GDP (in U.S. dollars) in 1965. World Development Indicators (2000) and Easterly and Sewedeh (2001).

Initial human capital: This indicator is the ratio of secondary school enrolment to gross in 1965. Data obtained from World Bank Development Indicators (2000) and Easterly and Sewedeh (2001).

Inflation: It measures the average growth rate of the consumer price index (CPI). Data obtained from World Development Indicators (2000) and Easterly and Sewedeh (2001).

Terms of Trade: Terms of trade effect equals capacity to import less exports of goods and services in constant prices. Data obtained from World Development Indicators (2000) and Easterly and Sewedeh (2001).

Exports as a share of GDP: It is the proportion of exports to GDP. It represents the value of all goods and other market services provided to or received from the rest of the world. Data obtained from World Development Indicators (2000) and Easterly and Sewedeh (2001).

Imports as a share of GDP: It is the proportion of imports to GDP. Data obtained from World Development Indicators (2000) and Easterly and Sewedeh (2001).

Ratio of Foreign Direct Investment to GDP: It measures the proportion of net inflows of investment to GDP. Data obtained from World Development Indicators (2000) and Easterly and Sewedeh (2001).

Ratio of Investment to GDP: This indicator measures the proportion of domestic investment to GDP. Data obtained from World Development Indicators (2000) and Easterly and Sewedeh (2001).

Aid as a proportion of GDP: Official development assistance and net official aid record the actual international transfer by the donor of financial resources or of goods or services valued at the cost to the donor, less any repayments of loan principal during the same period. Data obtained from World Development Indicators (2000) and Easterly and Sewedeh (2001).

Ratio of trade to GDP: is then sum of exports and imports of goods and services measured as a share of gross domestic product. Data obtained from World Development Indicators (2000) and Easterly and Sewedeh (2001).

Growth of export: is annual growth rate of exports of goods and services based on constant local currency. Data obtained from World Development Indicators (2000) and Easterly and Sewedeh (2001).

GDP Per capita PPP: is gross domestic product converted to international dollars using purchasing power parity rates. Data obtained from World Development Indicators (2000) and Easterly and Sewedeh (2001).

Export duties: includes all levies collected on goods at the point of export. Data obtained from World Development Indicators (2000) and Easterly and Sewedeh (2001).

Population growth: is based on the de facto definition of population, which accounts all residents regardless of legal status or citizenship except for refugees not permanently settled in the country of asylum. Data obtained from World Development Indicators (2000) and Easterly and Sewedeh (2001).

Female literacy rate: is the proportion of female adult aged 15 and above who can, with understanding, read and write. Data for illiteracy rate were obtained from Data obtained from World Development Indicators (2000), and for literacy rate is calculated using the female population.

Ratio of government consumption to GDP: includes all current spending for purchases of goods and services. Data obtained from World Development Indicators (2000) and Easterly and Sewedeh (2001).

Trading partners' GDP per capita growth: is the weighted average GDP per capita growth of the top five trading partners (weighted average by trade share). Data obtained Easterly and Sewedeh (2001).

Trade with OECD countries: is total trade (import +export) as percentage of GDP. Data obtained from Easterly and Sewedeh (2001).

Trading partners' tariff rate: is calculated using OECD countries weighted average tariff rates (weighted average by GDP).

Assassination: No of political assassinations per annum. Data obtained from Easterly and Sewedeh (2001).

Revolutions: number of revolutions and coup deta per annum. Data obtained from Easterly and Sewedeh (2001).

Infrastructure Indicators:

***Telephones and Telephone main lines per employee*:** Total telephones measures share the number of telephone sets, and includes cases where subscribers share a line, while main lines are the number of lines connected to local telephone exchanges. The number of telephone main lines per employee seems to be a better measure of the capacity of a telephone system. In theory, a better measure of infrastructure stock might be the capacity of telephone exchange (Canning, 1999). Data taken from Canning (1999) and World Development Indicators (2000).

***Paved Roads*:** Paved roads are defined as roads that have been sealed with asphalt or similar road building materials. Data obtained from Canning (1999) and World Development Indicators (2000).

***Electricity*:** This indicator reflects the electricity generating capacity of a country. We use electric power consumption per capita as a proxy (measured in kWh per capita). Data obtained from Canning (1999) and World Development Indicators (2000).

Openness Indicators

***Sachs-Warner*:** Based on the criteria discussed in Chapter 3, this binary index takes a value of 1 if the country is considered to be open in that particular year, and zero otherwise.

Data obtained from Sachs and Warner (1995). Since our analysis covers the period 1970-1999, we extrapolated some of the missing data following the same procedure as in Sachs and Warner (1995).

***World Development Report*:** This indicator classifies countries into four groups, based on their perceived degree of openness. The highest value (4) indicates more open economy, while the lowest value (1) implies closed economy. The detail of the criteria involved in this classification is discussed in Chapter 2. Data obtained from World Development Report (1987).

***Leamer*:** This openness index is estimated by Leamer (1988) as average residuals from disaggregated trade flows regression used (see Chapter 2 for detail).

***Black Market Premium*:** is the ratio of the black market exchange rate to the official rate minus one. It is usually used as a general indicator of policy interventions in foreign exchange market since eliminating intervention eliminates the premium. This indicator is assumed to be negatively associated with growth. Data obtained from Easterly and Sewedeh (2001)..

***Tariffs*:** The average tariff rate on imports. Data obtained from World Development Indicators (2000).

***Collected Trade Taxes Ratio*:** The ratio of total revenue on taxes on international trade (imports + exports) to total trade. Data obtained from World Development Indicators (2000).

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